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AMERICAN SOCIETY
FOR
TESTING MATERIALS

AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS

PROCEEDINGS
OF THE
NINETEENTH ANNUAL MEETING

Held at Atlantic City, New Jersey
June 27–30, 1916

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VOLUME XVI

PART I. COMMITTEE REPORTS
TENTATIVE STANDARDS

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SUMMARY OF THE PROCEEDINGS OF THE NINETEENTH ANNUAL MEETING.

Atlantic City, N. J., June 27–30, 1916.

The Nineteenth Annual Meeting of the American Society for Testing Materials was held at the Hotel Traymore, Atlantic City, N. J., on June 27–30, 1916. The following is an analysis of the attendance at the meeting: Members, in attendance or represented, 455; guests, 74; ladies, 130; total, 659; the corresponding statistics for the Eighteenth Annual Meeting in 1915 being: Members, in attendance or represented, 435; guests, 68; ladies, 102; total, 605.

The names of the members who where present or represented at the meeting are given in the appendix to this summary.

First Session—Tuesday, June 27, 11 a. m.

President Mansfield Merriman in the chair.

The minutes of the Eighteenth Annual Meeting were approved as printed.

The President appointed Mr. G. H. Woodroffe and Mr. Frank Zeleny as tellers to canvass the vote for officers.

The Secretary-Treasurer presented the annual report of the Executive Committee. On separate motions the proposed amendments of the by-laws, recommended by the Executive Committee, were individually approved without change for reference to letter ballot.

The Secretary-Treasurer called attention to the following paragraph in the report:

> "As pointed out in Circular No. 106, four of the six members of the nominating committee this year had served in a like capacity last

> year. The Executive Committee, after taking account of the circumstance that these four members had received the highest number of votes, was unwilling to assume the responsibility of discriminating against these members on the score of previous service. The Executive Committee wishes, however, to obtain an expression of the sense of this meeting as to the desirability of defining the future policy with reference to the successive appointment of the same individual on the nominating committee."

It was moved by Mr. A. A. Stevenson that the by-laws be amended to the effect that members who have served on the nominating committee shall be ineligible for appointment on the nominating committee for the immediately succeeding year. This motion was amended to provide also for the ineligibility of members of the Executive Committee to appointment on the nominating committee. The motion as thus amended was adopted.

A motion by Mr. P. H. Walker, that a list of the persons ineligible for service on the nominating committee be issued in connection with the notice inviting suggestions for appointment on this committee, and that the names of the last three Past-Presidents, who are ex-officio members of that committee, be also included in this notice, was carried.

The Secretary-Treasurer directed attention to the fact that the proposed amendment of the by-laws affecting the personnel of the nominating committee cannot be acted on till next year, and moved, as the sense of the meeting, that the provisions embodied in this proposed amendment be observed during the ensuing year. This motion was carried.

The President called attention to the action taken at a special meeting of the Executive Committee held that day by which the financial report contained in the annual report of the Executive Committee will be extended by publishing, for comparative purposes, a financial statement covering the period from June 1, 1915, to June 1, 1916, in the same form as in the annual report last year, and stated that this report as finally published in the Proceedings will also contain an abstract of the minutes of that special meeting.

The report of Committee E-5 on Standing Committees was presented by its chairman, Mr. Edgar Marburg.

The report of Committee A-2 on Wrought Iron was introduced by its chairman, Mr. S. V. Hunnings. On motion of Mr. Hunnings the recommendation of the committee that the proposed revisions in the Standard Specifications for Lap-Welded Iron Boiler Tubes (A 38–12) be referred to letter ballot of the Society, was approved.

The report of Committee E-6 on Papers and Publications was presented by its chairman, Mr. Edgar Marburg.

The tellers on the votes for election of officers presented their report and in accordance therewith the President announced the election of the following officers: For President, to serve for one year, A. A. Stevenson; for Vice-President, to serve for two years, S. S. Voorhees; for Members of Executive Committee, to serve for two years, W. H. Bassett, John Brunner, G. W. Thompson and F. E. Turneaure.

The President called attention to the new official gavel made from a water pipe laid in the city of Philadelphia in 1799, unearthed in 1905, and kindly made and presented to the Society by one of its members, Mr. J. A. Colby.

The President appointed Past-Presidents R. W. Hunt and A. W. Gibbs to escort the President-elect, Mr. A. A. Stevenson, to the chair. Mr. Stevenson expressed his appreciation of the honor conferred upon him through his election to the Presidency and pledged himself to the faithful discharge of his duties.

The meeting then adjourned till 3 P. M.

SECOND SESSION—TUESDAY, JUNE 27, 3 P. M.

On Miscellaneous Materials.

Genl. W. H. Bixby, Vice-President, in the chair.

The report of Committee D-3 on Methods of Laboratory Sampling and Analysis of Coal was, in the absence of its chairman, Mr. S. W. Parr, presented by Mr. A. C. Fieldner. On motion the recommendation that the Tentative Methods for Laboratory Sampling and Analysis of Coal, as printed in the

1915 Year-Book, be referred, with certain minor amendments, to letter ballot of the Society, was carried.

The report of Committee D-5 on Coal was presented by its chairman, Mr. G. S. Pope. On motion of Mr. Pope the recommendation of the committee that the Tentative Methods for Sampling of Coal, as published in the 1915 Year-Book, be referred, with certain amendments, to letter ballot of the Society, was carried.

The report of Committee D-10 on Shipping Containers was, in the absence of its chairman, Col. B. W. Dunn, presented by Capt. G. E. Carleton.

A paper on "The Development of a Box-Testing Machine and Some Results of Tests," supplementary to the report of Committee D-10, by Mr. J. A. Newlin and Mr. T. R. C. Wilson, was briefly summarized by Mr. Newlin.

The report of Committee D-11 on Rubber Products was introduced by its chairman, Mr. E. A. Barrier. On motion of Mr. Barrier the proposed Tentative Specifications for 2½, 3 and 3½-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use were accepted for publication, with certain amendments, among the Tentative Standards in the Proceedings.

On the recommendation of the committee the proposed Tentative Specifications for Insulated Wire and Cable: 30 per cent Hevea Rubber, as printed in the 1915 Proceedings,[1] were accepted for publication, with certain amendments, among the Tentative Standards in the Proceedings.

The report of Committee D-13 on Textile Materials was presented by its chairman, Mr. W. D. Hartshorne. The recommendation of the committee that the Tentative Tests for Automobile Tire Fabrics as published in the 1915 Year-Book be accepted for publication, with certain amendments, among the Tentative Standards in the Proceedings under the title "Tentative General Methods for Testing Cotton Fabrics" was, on motion of Mr. Hartshorne, approved.

A motion by Mr. Hartshorne that the proposed Tentative Tests for (1) Automobile Tire Fabrics and (2) Cotton Fabrics for Use in Hose, Belting and Similar Articles be accepted for publication among the Tentative Standards in the Proceedings was carried.

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[1] Vol. XV, Part I, pp. 411–433 (1915).

The same action was taken, on motion of Mr. Hartshorne, with reference to the proposed Tentative Tests for Cotton Fabrics for Use in Bags and Bagging Material, provided that a subsequent letter ballot of Committee D-13 on these proposed tentative tests should be carried without a dissenting vote, this item not having previously been submitted to letter ballot of the committee, as required by the Regulations Governing Standing Committees.[1]

The meeting then adjourned till 8 P. M.

THIRD SESSION—TUESDAY, JUNE 27, 8 P. M.

President-elect A. A. Stevenson in the chair.

The Presidential Address entitled "The Work of Committees" was delivered by the retiring President, Mr. Mansfield Merriman.

A joint paper on "Notes on the Hardening and Tempering of Eutectoid Carbon Steel and on the Shore Test," by Mr. Henry M. Howe and Mr. Arthur G. Levy, was summarized by Mr. Howe and discussed.

A paper on "Some Experiments on the Plastic Elongation of Wire," by Mr. A. V. de Forest, was presented by the author and discussed.

The report of Committee D-1 on Preservative Coatings for Structural Materials was introduced by its chairman, Mr. P. H. Walker. The recommendation of the committee that the proposed revisions in the Standard Specifications for Purity of Raw Chinese Wood Oil (D 12-15) be referred to letter ballot of the Society was, on motion of Mr. Walker, approved.

The following proposed tentative standards were, on motion of Mr. Walker, accepted for publication among the Tentative Standards in the Proceedings:

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[1] The subsequent vote by letter ballot of Committee D-13 was affirmative without a dissenting vote, and the specifications are therefore printed among the Tentative Standards, pp. 534-535.—ED.

1. Tentative Tests for Distillation of Paint Thinners Other than Turpentine, designed to supersede the tentative distillation test published in the 1915 Year-Book, and to include the proposed tentative specific-gravity test referred to in detail in this year's report of Committee D-1.

2. Tentative Tests for Shellac, comprising (*a*) Determination of Rosin in Shellac and (*b*) Determination of Insoluble Matter in Shellac, published in 1914, and (*c*) Determination of Moisture in Bleached Shellac, published in the 1915 Year-Book as tentative.

3. Tentative Methods for Routine Analysis of White Pigments, in the same form as previously published in the 1915 Year-Book.

A paper on "The Acceptability of Linseed Oil," by Mr. C. D. Holley, was, in the absence of the author, introduced by title and discussed.

The meeting then adjourned till the following morning.

FOURTH SESSION—WEDNESDAY, JUNE 28, 10 A. M.

On Steel and Iron.

Past-President Henry M. Howe in the chair.

The report of Committee A-1 on Steel was introduced by its chairman, Mr. C. D. Young.

Mr. Young moved that the proposed revisions of the following present standards be approved and referred to letter ballot of the Society (this motion requiring a nine-tenths affirmative vote of those voting):

Standard Specifications for:

Structural Steel for Bridges (A 7–15);
Structural Nickel Steel (A 8–14);
Structural Steel for Buildings (A 9–14);
Structural Steel for Locomotives (A 10–14);

Structural Steel for Cars (A 11–14);
Structural Steel for Ships (A 12–14);
Carbon-Steel Bars for Railway Springs (A 14–14);
Carbon-Steel and Alloy-Steel Forgings (A 18–14);
Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 19–14);
Carbon-Steel Forgings for Locomotives (A 20–14);
Cold-Rolled Steel Axles (A 22–14);
Steel Castings (A 27–14);
Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes (A 28–13);
Boiler and Firebox Steel (A 30–14).

An amendment by Mr. C. L. Huston that the proposed revised Standard Specifications for Boiler and Firebox Steel be excepted, was accepted by Mr. Young, and the motion as thus amended was unanimously carried.

Mr. Young then moved that the proposed revisions of the present Standard Specifications for Boiler and Firebox Steel be also approved and referred to letter ballot of the Society. Mr. Huston offered an amendment that the proposed revisions of Sections 8(*a*), 8(*b*), 10 and 11(*a*)[1] in these specifications be withheld from the letter ballot, and that they be published among the Tentative Revisions of Standards in the Proceedings.

The vote on this amendment was lost and Mr. Young's original motion was carried.

On motion of Mr. Young the following proposed revised specifications were unanimously approved and referred to letter ballot of the Society (this motion requiring a nine-tenths affirmative vote of those voting):

Proposed Revised Specifications for:

Wrought Solid Carbon-Steel Wheels for Steam Railway Service (combination and revision of Standard Specifications A 23–12 and A 24–12);
Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–13);
Steel Tires (A 26–14).

---

[1] These revisions are given on pp. 120–121.—ED.

On motion of Mr. Young the following tentative specifications in their present form, or as amended by the committee, were approved and referred to letter ballot of the Society:

Proposed New Standard Specifications for:

Carbon-Steel Bars for Vehicle and Automobile Springs;
Silico-Manganese-Steel Bars for Automobile and Railway Springs (as amended);
Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (as amended);
Helical Springs for Railways;
Elliptical Springs for Railways;
Alloy-Steel Forgings (as amended; to be combined with Specification A 18–14);
Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (as amended).

On motion of Mr. Young the following proposed tentative specifications were accepted for publication among the Tentative Standards in the Proceedings:

Proposed Tentative Specifications for:

Steel Track Spikes;
Steel Screw Spikes;
Steel Tie Plates;
Carbon-Steel Bars for Railway Springs with Special Silicon Requirements;
Elliptical Springs for Automobiles;
Boiler and Firebox Steel for Stationary Service.

On motion of Mr. Young the following recommendations of the committee were approved:

1. That the Standard Methods for Chemical Analysis of Plain Carbon Steel (A 33–14) and of Alloy Steels (A 55–15) be revised by the addition of the explanatory sentence noted in the report under the heading "Methods of Chemical Analysis."

2. That the proposed revision of the requirements for 2-in. tension test specimens, as given in the report under the heading

"Methods of Physical Tests," and as amended subsequently by the committee, be made in all specifications affected.

3. That the sections on Ladle and Check Analyses in the various specifications be revised as to form as indicated in the report under the heading "Literary Form."

On motion of Mr. Young certain amendments in the following present standard specifications, recommended by the committee, were approved and referred to letter ballot of the Society:

Standard Specifications for:

Quenched Carbon-Steel Track Bolts (A 50–15);
Quenched Alloy-Steel Track Bolts (A 51–15);
Automobile Carbon and Alloy Steels (A 29–15).

The report of Committee A-4 on Heat Treatment of Iron and Steel, Mr. Albert Sauveur, chairman, was, in the absence of the chairman, presented by Mr. J. H. Hall, secretary.

Mr. C. D. Young introduced motion pictures exhibiting the methods used in the Pennsylvania Railroad laboratories at Altoona, Pa., for the determination of the elastic limit by means of extensometers.

The chair announced that, at the request of President Merriman, he had the pleasure of presenting and extending the privilege of the floor to Prof. A. G. Van Hecke, of the University of Louvain, who he hoped would favor the meeting with a few remarks. Professor Van Hecke expressed his high appreciation at having been given this opportunity to address the meeting. He referred briefly to the effect of the European war on the University with which he was connected and mentioned by name a number of men prominently identified with the testing of materials whose death had occurred during the war. He expressed the hope that his University would, in due course, be rehabilitated and that this and other similar organizations might assist toward that end. In closing he referred to the deep appreciation of his compatriots for American aid which had come to their country in such large measure. The chairman wished Professor Van Hecke and his University godspeed in their proposed undertaking.

A paper on "National Standard Specifications and Their

Relation to Export Trade," was, in the absence of the author, Mr. William R. Webster, read by title.

A paper on "Heat Treatment of Carbon-Steel Locomotive Axles: Water vs. Oil Quenching," by Mr. C. D. Young, was presented by the author and discussed.

A paper on "Recrystallization as a Factor in the Failure of Boiler Tubes," under the joint authorship of Mr. A. E. White and Mr. H. F. Wood, was presented by Mr. White and discussed.

The report of Committee A-5 on Corrosion of Iron and Steel was presented by its chairman, Mr. S. S. Voorhees.

The report of Committee A-6 on Magnetic Properties of Iron and Steel was introduced by its chairman, Mr. C. W. Burrows. On motion of Mr. Burrows, the recommendation of the committee that certain proposed changes in the Standard Tests for Magnetic Properties of Iron and Steel (A 34–14) be accepted for publication among the Tentative Revisions of Standards in the Proceedings, was approved.

At the invitation of the Chairman President-elect A. A. Stevenson assumed the chair and Mr. Henry M. Howe introduced the following resolution, which, on motion of Mr. Howe, was referred to the Executive Committee for consideration and further recommendation:

> "Recognizing the confusion, inconvenience, and loss of time and efficiency occasioned by the lack of uniformity in recording temperatures in this country; and recognizing further that the Centigrade scale is much simpler and more convenient than the Fahrenheit scale and is the present standard in all other countries except Great Britain, and is also in general use among scientific men throughout the world:
>
> "It is the sense of this meeting of the American Society for Testing Materials, that the efforts being made to obtain legislation requiring the use of the Centigrade scale in all future Government publications should be heartily approved."

The meeting then adjourned till 8 P. M.

FIFTH SESSION—WEDNESDAY, JUNE 28, 8 P. M.

On Tests and Testing.

President Mansfield Merriman in the chair.

The report of Committee E-1 on Methods of Testing was presented by its chairman, Mr. Gaetano Lanza. On motion of Mr. Lanza certain revisions in the present Methods for Tension and Compression Tests of Metals (E 1–15) were approved and referred to letter ballot of the Society.

A topical discussion on "The Relation between Yield Point and Proportional Limit in Various Grades of Steel" was formally opened by Mr. T. D. Lynch and Mr. H. F. Moore, the latter on behalf of himself and Mr. F. B. Seely. A formal contribution to this discussion by Mr. J. E. Howard was, in the absence of the author, read by title. The discussion was then thrown open to the meeting.

The acting secretary reported that the Executive Committee had approved the resolution introduced by Mr. Henry M. Howe at the fourth session. On motion of Mr. C. D. Young the resolution referred to was adopted.

A paper on "An Apparatus for Determining Soil Pressures," by Mr. A. T. Goldbeck and Mr. E. B. Smith, was presented by Mr. Goldbeck and discussed.

A paper on "Endurance and Impact Tests of Metals" was introduced by the author, Mr. D. J. McAdam, Jr., and discussed.

A paper on "Constants and Diagrams for Repeated-Stress Calculations," under the joint authorship of Mr. H. F. Moore and Mr. F. B. Seely, was presented by Mr. Moore.

A paper on "Method for Testing the Durability of Pipe under Corrosion," by Mr. F. N. Speller, was presented by the author and discussed.

The meeting then adjourned till the following morning.

SIXTH SESSION—THURSDAY, JUNE 29, 10 A. M.

On Cement and Concrete.

Mr. Robert W. Lesley in the chair.

The report of Committee C-1 on Cement was, in the absence of the chairman, Mr. G. F. Swain, presented by the secretary of the committee, Mr. Richard L. Humphrey.

Mr. Humphrey moved that the recommendation of the committee that the proposed revised Specifications and Methods of Tests for Portland Cement be referred to letter ballot of the Society, with certain amendments proposed by the committee, be approved with the understanding that if the vote should be affirmative they shall become effective on January 1, 1917. This motion was carried.

Mr. C. D. Young inquired whether the adoption of that motion carried with it the change of title recommended by the committee by which these specifications would be known as American Specifications and Methods of Tests for Portland Cement. The chairman replied that he thought it did. Mr. Young stated that in that case adequate opportunity for discussion should have been given, and that he understood that the Executive Committee had given consideration to this matter, and that at least the report of the Executive Committee should have been announced before taking action. He accordingly moved that the previous action on the report be reconsidered with a view of discussing the proposed change of title.

Mr. R. J. Wig offered an amendment to that motion that the reconsideration be made to apply not only to the title but to any other recommendations of the committee affecting the specifications themselves.

Mr. Young accepted this amendment and the motion as thus amended was carried.

President Mansfield Merriman requested the Secretary to present the report of the action of the Executive Committee on the proposed change of title of these specifications.

The acting Secretary accordingly reported this action as follows:

> "That the recommendation in the annual report of Committee C-1, 'that the proposed revised Specifications

> for Portland Cement be given the title American Specifications and Methods of Tests for Portland Cement' be not approved.
>
> "That it is the sense of the Executive Committee that the purpose which Committee C-1 has in view in making this recommendation might be covered by a footnote to the title of the specifications reading about as follows:
>
> "These specifications are the result of several years' work of a special committee representing the United States Government Departmental Committee; the Board of Direction of the American Society of Civil Engineers; as well as Committee C-1 of the American Society for Testing Materials."

After considerable discussion Mr. Young moved that the entire matter, as well as any future questions affecting titles of standards, be left with power to the Executive Committee.

After considerable further discussion this motion was carried by unanimous vote.

Mr. Humphrey then moved that the proposed revised Specifications and Methods of Tests for Portland Cement be approved and referred to letter ballot of the Society, with the understanding that if the vote should be affirmative these standards shall become effective on January 1, 1917.

The Secretary-Treasurer presented a written discussion by Mr. B. A. Howes, and another written discussion by Mr. J. A. Kitts, which latter, on account of its technical nature, was read in abstract only.

Mr. Humphrey stated that these discussions had both received consideration by Committee C-1 at a recent meeting at which the proposed specifications and methods of tests had been subjected to final revision; also that another written discussion by Mr. Bernard Enright had been withdrawn by request of its author.

The Secretary-Treasurer explained that under the by-laws these proposed revised standards could be referred to letter ballot for adoption, without having previously been published among the Tentative Standards, only by a nine-tenths vote of those voting at this session. Mr. Humphrey's motion was then put and carried by unanimous vote.

Mr. Humphrey explained that this action would leave the present Standard Specifications for Natural Cement unaffected, and that the committee intends to give consideration to the revision of these specifications during the ensuing year.

Mr. Humphrey moved that the recommendation of the committee, that the proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar be accepted for publication among the Tentative Standards in the Proceedings, be approved. After considerable discussion this motion was carried.

Mr. Humphrey moved that a vote of thanks be extended to the representatives of the United States Government and the American Society of Civil Engineers on the Joint Conference through whose cooperation the attainment of a single specification for Portland cement had been developed. This motion was carried by unanimous vote.

The reports of the following committees were then presented by their respective chairmen:

Committee C-9 on Concrete and Concrete Aggregates, Mr. S. E. Thompson, chairman.

Committee D-8 on Waterproofing, Mr. W. A. Aiken, chairman.

A paper on "The Specific Gravity of Non-Homogeneous Aggregates," under the joint authorship of Mr. Prévost Hubbard and Mr. F. H. Jackson, Jr., was introduced by Mr. Jackson and discussed.

The following papers were then presented by their respective authors and discussed:

"The Strength of Clamped Splices in Concrete Reinforcement Bars," by Mr. E. L. Lasier.

"A Method of Making Wear Tests of Concrete," by Mr. D. A. Abrams.

"A New Form of Specifications for Concrete Aggregates," by Mr. Cloyd M. Chapman.

Mr. Thomas Nolan announced that the Board of Direction of the American Institute of Architects had recently taken steps toward the appointment of a "Committee on Materials and Methods" consisting of a chairman and sub-committeemen, one in the territory of each Chapter, authorized and directed to report fully any matters of interest concerning materials and methods to the chairman. He in turn is instructed to forward such reports to the Secretary of the Institute for final disposition.

The meeting then adjourned till 3 P. M.

SEVENTH SESSION—THURSDAY, JUNE 29, 3 P. M.

On Ceramics, Road Materials and Gypsum.

Genl. W. H. Bixby, Vice-President, in the chair.

The report of Committee C-4 on Clay and Cement Sewer Pipe was presented by its chairman, Mr. Rudolph Hering.

On motion of Mr. Hering the recommendation of the committee that the Tentative Recommended Practice for the Laying of Sewer Pipe, as published in the 1915 Year-Book, be again published with certain minor changes among the Tentative Standards in the Proceedings, was approved.

The report of Committee C-6 on Drain Tile was introduced by its chairman, Mr. A. Marston, and discussed.

On motion of Mr. Marston the recommendation of the committee that the proposed revised Standard Specifications for Drain Tile (C 4–14) be referred to letter ballot of the Society (this motion requiring a nine-tenths affirmative vote of those voting) was carried by unanimous vote.

A paper on "Practical Methods for Testing Refractory Fire Brick," under the joint authorship of Mr. C. E. Nesbitt and Mr. M. L. Bell, was introduced by Mr. Nesbitt and discussed.

The report of Committee D-4 on Road Materials was, in the absence of the chairman, Mr. L. W. Page, presented by Mr. A. W. Dow. Mr. Dow moved that the recommendations in the report of the committee affecting Standards be approved.

The Secretary-Treasurer pointed out that these recommendations fell in several categories, some being in accord with the Regulations Governing Standing Committees, and others being exceptional and requiring a nine-tenths vote of those voting, so that it seemed necessary to take separate action on the recommendations of the committee. He accordingly moved that the recommendation of the committee that certain Definitions of Terms Relating to Materials for Roads and Pavements be published among the Tentative Revisions of Standards in the Proceedings. This motion was carried.

The Secretary-Treasurer then moved that the recommendations of the committee that the following proposed revised standard tests and methods be referred to letter ballot of the Society be approved, with the understanding that if the motion be seconded the committee will be invited to show cause why the regular procedure by which such revisions are first published among the Tentative Revisions of Standards in the Proceedings, should not be followed:

Standard Test for Penetration of Bituminous Materials (D 5–11);
Standard Test for Loss on Heating of Oil and Asphaltic Compounds (D 6–11);
Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregate Used in Cement Concrete (D 7–11).

After explanations by members of the committee this motion was carried.

The Secretary-Treasurer then moved, subject to subsequent satisfactory explanation by the committee, that its recommendation that the proposed Standard Test for Determination of Apparent Specific Gravity of Homogeneous Coarse Aggregates be referred to letter ballot of the Society, be approved.

After considerable discussion this motion was lost and a substitute motion that this proposed standard test be accepted for publication among the Tentative Standards in the Proceedings was approved.

On motion of the Secretary-Treasurer the recommendation of the committee that the proposed Standard Method for Making a Mechanical Analysis of Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete, be referred to letter ballot of the Society, was approved.

On motion of Mr. Dow the recommendation of the committee that the proposed Standard Method for Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete, be referred to letter ballot of the Society, was approved.

On motion of Mr. Dow like action was taken on the proposed Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment.

On motion of Mr. D. E. Douty the proposed Standard Form of Specifications for Certain Commercial Grades of Broken Stone was accepted for publication among the Tentative Standards in the Proceedings.

Mr. Prévost Hubbard moved that the recommendation of the committee that the proposed Standard Method for Determination of Softening Point of Bituminous Materials Other than Tar Products be referred to letter ballot of the Society be approved. This motion was lost.

On motion of Mr. Douty this proposed standard method was accepted for publication among the Tentative Standards in the Proceedings.

The report of Committee C-11 on Gypsum and Gypsum Products was then presented by its chairman, Mr. R. J. Wig.

Mr. Wig moved on behalf of the committee that the report be referred back to the committee and that only the following parts be printed in the Proceedings: The first paragraph on page 1; the last paragraph on page 3; the first four paragraphs on page 4, down to the words "Sub-Committee III, etc.," and all the matter on pages 37–56 incl., with the understanding that the last item, namely proposed Tentative Definitions of Terms Relating to the Gypsum Industry, be published among the Tentative Standards.

Mr. F. E. Schmitt proposed, as an amendment to this motion, that definitions Nos. 7 and 8, relating to cement and concrete respectively, be omitted.

The Secretary-Treasurer suggested, as a proposed substitute amendment, that these definitions be not omitted, but that the committee be instructed to embody in a future report, when the definitions will be subject to final action, (1) reasons for including definitions which apparently do not logically belong in the field of gypsum, and (2) specific and detailed reference to the definitions of cement and concrete in their present or revised form.

This substitute amendment was accepted by Mr. Schmitt and also by Mr. Wig. Mr. Wig's original motion, as thus amended, was carried.

The meeting then adjourned till the following morning.

EIGHTH SESSION—FRIDAY, JUNE 30, 10 A. M.

On Non-Ferrous Metals.

President Mansfield Merriman in the chair.

The report of Committee B-1 on Copper Wire was presented by Mr. W. H. Bassett, in the absence of the chairman, Mr. J. A. Capp.

Mr. Bassett moved that the Tentative Specifications for Bare Concentric-Lay Copper Cable: Hard, Medium-Hard or Soft, as published in the 1915 Year-Book, with certain proposed amendments, and the Tentative Specifications for High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity, as published in the 1915 Year-Book, be submitted to letter ballot of the Society. This motion was carried.

The report of Committee B-2 on Non-Ferrous Metals and Alloys was presented by Mr. W. H. Bassett, in the absence of the chairman, Mr. Wm. Campbell.

Mr. Bassett stated that, although in its report the committee had recommended that certain amendments in the present Standard Specifications for Spelter (B 6–14) be referred to letter ballot of the Society (which would be permissible only by a nine-tenths vote of those voting), it had since seemed desirable to him and certain other members of the committee that these proposed amendments be first published among the Tentative Revisions of Standards in the Proceedings, and he so moved, with the understanding that, in case of affirmative vote, this change would be further contingent upon its subsequent approval by letter ballot of the committee without a single dissenting vote[1]. This motion was carried.

Mr. Bassett moved that the following proposed tentative specifications be accepted for publication among the Tentative Standards in the Proceedings:

Specifications for:

Copper Plates for Locomotive Fireboxes;
Copper Bars for Locomotive Staybolts;
Seamless Copper Boiler Tubes;
Seamless Brass Boiler Tubes;
Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings, and Finished Car and Tender Bearings.

Mr. S. V. Hunnings moved as an amendment that all reference to steam metal, red brass, yellow brass and brazing metal in the proposed Tentative Specifications for Non-Ferrous Alloys, etc., be stricken out. This amendment was lost.

The original motion by Mr. Bassett was then carried.

On motion of Mr. J. L. Jones this action was reconsidered.

Mr. Jones then moved that the proposed Tentative Specifications for Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings, and Finished Car and Tender Bearings be referred back to the committee for further consideration. This motion was carried.

A motion that the remaining four proposed tentative specifications covered by the original motion be accepted for publication among the Tentative Standards in the Proceedings was then carried.

On motion of Mr. Bassett, the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent, as published in the 1915 Year-Book, were accepted for publication among the Tentative Standards in the Proceedings.

A paper on "Aluminum Bronze: Some Recent Tests and their Significance," under the joint authorship of Mr. W. M. Corse and Mr. G. F. Comstock, was presented by Mr. Corse and discussed.

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[1] The subsequent vote by letter ballot of Committee B-2 was affirmative without a dissenting vote, and the proposed revisions are therefore printed among the Tentative Revisions of Standards, pp. 583–589. ED.

A paper on "An Investigation Leading to Specifications for Brass Condenser Tubes," by Mr. A. E. White, was introduced by its author and discussed.

Mr. W. Reuben Webster (Bridgeport, Conn.) moved that the Executive Committee be requested to consider the creation of a committee to report on Standard Scales of Magnification for Microphotographs. This motion was carried.

The meeting then adjourned till 3 P. M.

NINTH SESSION—FRIDAY, JUNE 30, 3 P. M.

On Miscellaneous Materials.

President Mansfield Merriman in the chair.

The report of Committee A–3 on Cast Iron and Finished Castings was presented by its chairman, Mr. Richard Moldenke.

Before introducing this report Mr. Moldenke called attention to the recent death, under tragic circumstances, of Mr. Leslie S. Robertson, who, as Secretary of the British Standards Committee, had rendered signal services in connection with the standardization of specifications for Great Britain. On motion of Mr. Moldenke the assembly rose in token of respect to the memory of Mr. Robertson.

On motion of Mr. Moldenke the Tentative Methods for Sampling and Analysis of Pig and Cast Iron, as published in the 1915 Year-Book, were referred, with certain minor amendments in form, to letter ballot of the Society.

A paper on "An Apparatus for Testing the Standard Cast-Iron Arbitration Bar," by Mr. H. L. Morse, was, in the absence of the author, read by title.

The report of Committee D–6 on Coke was presented by its chairman, Mr. Richard Moldenke.

On motion of Mr. Moldenke the recommendation of the committee that the Tentative Specifications for Foundry Coke, as published in the 1915 Year-Book, be referred to letter ballot of the Society, was approved.

Mr. Moldenke moved that the proposed Tentative Methods for Laboratory Sampling and Analysis of Coke be accepted for publication among the Tentative Standards in the Proceedings as a proposed future addendum to the Standard Specifications for Foundry Coke. This motion was carried.

The report of Committee D-7 on Timber was presented by Mr. S. R Church, in the absence of the chairman, Mr. Hermann von Schrenk.

On motion of Mr. Church the recommendation of the committee that the proposed Tentative Specifications for Selected Structural Douglas Fir Bridge and Trestle Timber be accepted for publication among the Tentative Standards in the Proceedings, was approved.

On motion of Mr. Church the recommendation of the committee that the proposed revised Tentative Methods for Sampling and Analysis of Creosote Oil be accepted for publication among the Tentative Standards in the Proceedings, was approved.

Mr. Church announced on behalf of the committee that the proposed Tentative Specifications for Wooden Paving Blocks would be withdrawn for further consideration by the committee.

On motion of Mr. Church, the Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted and the Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted, each as published in the 1915 Year-Book, were accepted for publication among the Tentative Standards in the Proceedings.

The following papers were then presented by their respective authors and discussed:

"Quantitative Test for Resistance of Lubricating Oils to Emulsification," by Mr. W. H. Herschel.

"Emulsification of Mineral Lubricating Oils: Apparatus and Test Method," by Mr. P. H. Conradson.

The Chair then declared the meeting adjourned *sine die.*

APPENDIX.

MEMBERS PRESENT OR REPRESENTED.

A

Abrams, D. A.
Ackerman, Ernest R.
Aertsen, G.
Affleck, Benjamin F.
Agricultural and Mechanical College of Texas,
  D. W. Spence.
Aiken, W. A.
Allen, Henry B.
American Brass Co.,
  W. H. Bassett.
American Bridge Co.,
  C. G. E. Larsson.
American Cement and Plaster Co.,
  E. Tupper.
American Foundrymen's Association,
  A. O. Backert.
American Institute of Architects,
  Thomas Nolan.
American Locomotive Co.,
  S. V. Hunnings.
American Steel and Wire Co.,
  S. M. Rodgers.
American Vulcanized Fiber Co.,
  William Eves, 3d.
Amies Road Co., .
  W. T. Newcomb.
Armstrong, V. C.
Ashton, Ernest.
Aston, James.
Atlantic Refining Co.,
  F. C. Robinson.

B

Babcock, Guilford C.
Backert, A. O.
Baldwin Locomotive Works,
  J. A. Hance.
Balz, George A.
Barber Asphalt Paving Co.,
  J. S. Miller, Jr.
Barbour, Frank A.
Barrett Manufacturing Co.,
  S. R. Church.
Barron, E. T.
Bartlett, G. S.
Bartlett, Henry.
Bates, P. H.
Beach, William M.
Beaver Mills,
  Charles M. Sears.
Beck, Wesley J.
Bellis, Arthur E.
Bemis Brothers Bag Co.,
  A. H. Clarke.
Berry, H. C.
Bethlehem Steel Co.,
  E. O'C. Acker.
Bird, Robert M.
Bishopric, Allison.
Bitting, A. W.
Bixby, W. H.
Blackmer, L. G.
Blair, Will P.
Blakeley, Abraham G.
Blanchard, Arthur H.
Bleininger, A. V.
Boggs, C. R.
Boonton Rubber Manufacturing Co.,
  R. W. Seabury.
Boyd, James K.
Boyer, Edward D.
Boynton, Henry C.
Brady, William.
Bridgeport Brass Co.,
  W. R. Webster.
Brighton Mills,
  W. O. Jelleme.
Brooks, Benjamin.
Brown & Co., Inc.,
  James Neale.
Brown, G. S.
Brown, H. J.
Browne, D. B.
Brunner, John.
Buck, D. M.
Bureau of Construction and Repair, U. S. N.,
  Lloyd Bankson.
Bureau of Steam Engineering, U. S. N., (Washington),
  H. E. Cook.
Bureau of Steam Engineering, U. S. N., (Annapolis),
  D. J. McAdam, Jr.
Burgess, George K.
Burrows, Charles W.
Butler, George.
Byers Co., A. M.
  R. W. Kenney,
  R. H. Seale.

C

Calumet Steel Co.,
  A. S. Hook.
Cambria Steel Co.,
  G. E. Thackray.
Camp, A. D.
Campbell, Sumner E.
Capp, J. A.
Carleton, Guy E.
Carnegie Steel Co.,
  C. F. W. Rys.
Carpenter Steel Co.,
  J. H. Parker.
Cement Era, The,
  George D. Steele.
Central Foundry Co.,
  Harry Y. Carson.
Central Iron and Steel Co.,
  Robert Irons.
Charls, G. H.
Cheesman, Frank P.
Child, J. Leo.
Christie, A. J.
Cobb, Ernest B.
Colby, Albert Ladd.
Coleman, R. E.
Condit, E. A., Jr.
Conn, Charles F.
Connolly, R. D.
Conradson, P. H.
Cook, Oscar U.
Cooper, William A.
Corse, William M.
Cramp and Sons, William,
  W. A. Dobson.
Crane Co.,
  L. W. Spring.
Crawford, C. H.
Crawford, J. C.
Crescent Portland Cement Co.,
  O. C. Hasse.
Cromwell, O. C.
Crowe, John J.
Crume, W. H.
Cushman, Allerton S.

D

Dannerth, Frederic.
Davies, George C.
Davis, J. E.
Davis, Nathan H.
Davis, S. D.
De Armond, Frank L.
De Forest, Alfred V.
De Knight, Edward W.
Detroit-Edison Co., The,
  C. F. Hirshfeld.
Devries, Ralph P.
Dewar, John.
Dickey, Walter S.
Diekmann, George P.
Diller, H. E.
Disston and Sons, Henry,
  A. Merzbacher.
Douty, D. E.
Dow, A. W.
Draney, J. R.
Drew, Harry.
Dunbar, W. O.
Dunlap Tire and Rubber Co.,
  D. E. Beynon.
Dunn, W. R.
Duquesne Slag Products Co.,
  J. M. Gorhring.

E

Eddy, Harrison P.
Edgerly, Daniel W.
Electrical Testing Laboratories,
  F. M. Farmer.
Elliott, George K.
Ellis, A. R.
Ellis, Theodore H.
Emley, Warren E.
Engineering Record,
  E. J. Mehren.
Enright, Bernard.
Erie Forge Co.,
  G. W. J. Stout.

F

Farran, William J.
Felton, George E.
Ferguson, Lewis R.
Fieldner, A. C.
Firestone Fire and Rubber Co.
  J. A. Schweizer.
Fitch, Roy O.
Fletcher, Austin B.
Force, H. J.
Ford, Allen P.
Franklin Steel Co.,
  E. E. Hughes.
French, James.
French, J. Hansell.
Fry, Lawford H.
Fulweiler, W. H.

G

Gage, Roscoe M.
Gano, William.
Gardner, Henry A.
Gates, John S.
General Electric Co.,
  J. A. Capp.

General Electric Co., Fort Wayne,
H. Herman.
General Electric Co., Lynn Works,
J. M. Darke.
Geological Survey of New Jersey,
R. B. Gage.
Gibbs, A. W.
Gilkyson, Ira L.
Glasgow Iron Co.,
J. P. Roe.
Goldbeck, Albert T.
Goldstein, H. I.
Goodell, John M.
Goodspeed, G. M.
Goodyear Tire and Rubber Co.,
Theodore Wood.
Greene, Hermann L.
Greenman, Russell S.
Gregory, E. D.
Grindlay, L. B.
Gulick, Henry, Jr.
Gypsum Industries Association,
G. S. Webb.

H

Hagy Waste Works, J. Milton,
Ralph L. Hays.
Hall, John H.
Harding, W. H.
Harrington, C. O., Jr.
Hart, O. C.
Hartford Steam Boiler Inspection and Insurance Co.,
W. J. Farran.
Hartranft Cement Co., William G.,
William G. Hartranft.
Hartshorne, William D.
Hartwell, S. W.
Hartzell, H. S.
Harvey, Dean.
Hatt, William K.
Hawk, Lester C.
Hay, J. T.
Heckel, G. B.
Hemstreet, George P.
Henry, J. A.
Hering, Rudolph.
Herschel, Winslow H.
Hicks, Thomas A.
Hill, Joseph C.
Holst, J. L.
Hopkins, George A.
Hough, Norman G.
Howe, Henry M.
Howson, E. T.
Hubbard, Prevost.
Humphrey, Richard L.
Hunnings, S. V.
Hunt and Co., Robert W.
Robert W. Hunt.

I

Ickes, E. T.
Illinois Steel Co.,
P. E. Carhart.
Ingalls, F. P.
Inspection Department, Associated Factory Mutual Fire Insurance Cos.,
E. A. Barrier.
Interocean Oil Co.,
Leroy M. Law.
Iron Age, The,
A. I. Findley,
W. W. Macon.

J

Jackson, Frank H., Jr.
Jaquith, Horace J.
Jeffers, John M.
Jeffries, L.
Jennison, H. C.
Job, Robert.
Johnson, A. L.
Johnson, A. N.
Johnson, J. S. A.
Johnson, Reeves K.
Jones, Jesse L.
Jones and Laughlin Steel Co.,
J. J. Shuman.

K

Kaiser, Frank H.
Kelley, F. W.
Kenney, E. F.
Kenney, L. H.
Kershaw, William H.
Keystone Fireproofing Co.,
G. S. Webb.
Kinney, William M.
Kleeburg, Felix.
Klein, W. H.
Klotz, J. R. M.
Koch, George B.

L

Lackawanna Steel Co.,
F. E. Abbott.
Laclede-Christy Clay Products Co.,
R. D. Hatton.
Lane and Co., J. H.,
C. B. Finckel.
Lanza, Gaetano.
Larned, E. S.
Larsson, C. G. E.

Lasier, E. L.
Lawson, T. R.
Lee Tire and Rubber Co.,
  E. E. Dearth.
Leech, J. O.
Leeds and Northrup Co.,
  Henry Brewer.
  C. R. Carry,
  G. H. English.
Lehigh Valley Railroad Co.,
  S. E. Printz.
Lesh, Ira B.
Lesley, Robert W.
Lindau, A. E.
Linder, Oscar.
Lindsay, Charles F.
Lowe Brothers Co., The,
  L. H. McFadden.
Lucas and Co., John,
  L. P. Nemzek.
Lukens Iron and Steel Co.,
  Charles L. Huston.
Lumen Bearing Co.,
  N. K. B. Patch.
Lunn, Charles A.
Lynch, T. D.
Lysle, Frederic B.

M

MacFarland, H. B.
Macgregor, James S.
MacGregor, John R.
Mackenzie, K. G.
Macnichol, Charles.
MacPherran, R. S.
Mallory, W. S.
Marble, Edwin H.
Marburg, Edgar.
Marion Steam Shovel Co.,
  Ralph A. Young.
Marsh, C. P.
Marston, A.
Masury and Son, J. W.,
  F. P. Ingalls.
Mathews, John A.
Mathias, David L.
Mattimore, H. S.
Maurer, E. R.
McCombe, A. S.
McDonnell, M. E.
McEntire, Lloyd M.
McIntyre, William A.
McNiff, G. P.
Meriwether, Coleman.
Merriman, Mansfield.
Metallurgical and Chemical Engineering.
  R. C. Bergen.
Midvale Steel Co.,
  G. Aertsen.
Miller, J. S., Jr.
Miller Rubber Co., The,
  A. E. Warner.
Millwood, J. P.
Miner, J. L.
Moldenke, Richard.
Moore, Henry A.
Moore, H. F.
Murphy, Louis E.
Murray, John F.
Myers, J. E.

N

Nashville, Chattanooga and St. Louis Railway Co.,
  George F. Blackie.
National Malleable Castings Co.,
  H. A. Schwartz.
National Tube Co.,
  F. N. Speller.
Neale, L. I.
Nellis, J. C.
New Jersey Zinc Co.,
  W. H. Hendricks.
Newkirk, Walter M.
Newlin, J. A.
Newport News Shipbuilding and Dry Dock Co.,
  John W. Gray.
New York Central Railroad Co., Engineering Department,
  A. W. Carpenter.
Nichols, R. M.
Norris, George L.
Northern Pacific Railroad Co.,
  H. G. Burnham.
Norton Co.,
  Ross C. Purdy.

O

Oberkirch, Frank.
Olsen, Thorsten Y.
Olson, L. W.
Orton, Edward, Jr.
Outerbridge, Alex. E., Jr.

P

Page, L. W.
Paisley, John W.
Parmelee, C. W.
Patton Clay Manufacturing Co.,
  G. E. Prindible.
Patton Paint Co.,
  Benjamin L. Solomon.
Pease, B. H.
Peirce, Edwin H.

Penn Seaboard Steel Corporation,
W. S. Bickley.
Perrot, Emile G.
Petinot, N.
Phoenix Portland Cement Co.,
I. L. Gilkyson.
Pickard, Glenn H.
Pittsburgh Testing Laboratory,
John M. Bailey.
Pollock, Clarence Du Bois.
Pomeroy, L. R.
Pope, G. S.
Porter, J. Madison.
Portland Cement Association,
J. P. Beck.
Potts, Stephen C.
Prentiss, George N.
Pressel, George W.
Price, William B.
Provost, A. J., Jr.
Pullar, H. B.

Q

Quimby, Henry H.

R

Racine Rubber Co.,
H. B. Underwood.
Radcliffe, F. P.
Randall, Thomas A.
Rawson, Charles A.
Reading Iron Co.,
George Schuhmann.
Republic Iron and Steel Co.,
L. B. Grindlay.
Republic Rubber Co.,
N. W. Sayles.
Rew, W. E.
Rhode Island Tool Co.,
Chester B. Sadtler.
Richardson, Clifford.
Rigg, E. H.
Rinald, C. D.
Robinson, A. F.
Rock Products,
Fredrick K. Irvine.
Roebling's Sons Co., J. A.,
H. C. Boynton.
Rogers, Allen.
Rogers, R. E.
Royle and Sons, John,
Vernon E. Royle.

S

Sabin, A. H.
Sagendorph, George A.
Sanderson, John McE.
Sargent, George W.
Schaeffer, John A.
Schmid, M. H.
Schmitt, F. E.
Schoenfuss, F. H.
Schwartz, E. H.
Schwartz, H. A.
Scofield, H. H.
Scott and Co., Henry L.,
Henry L. Scott.
Seaton, Max Y.
Seaver, Kenneth,
Security Cement and Lime Co.,
Arthur C. Hewitt.
Sewer Pipe Manufacturers' Association, The,
John L. Rice.
Sharples, Philip P.
Shelley, H. T.
Skinner, C. E.
Slater, W. A.
Slocum, Frank S.
Smith, Francis P.
Smith, H. E.
Smith, Irving B.
Snow, J. P.
Spackman Engineering Co., Henry S.,
Henry S. Spackman.
Spencer, Herbert.
Stafford, Samuel G.
Stalknecht, A. C.
Standard Steel Works Co.,
A. A. Stevenson.
Stapleton, E. R.
Starr, John J.
Steel Co. of Canada, The,
J. S. Morrow.
Stewart, John T.
Stone, George C.
Stott, C. J.
Studebaker Corporation,
C. Newman Dawe.
Swan, O. T.

T

Tagliabue, C. J.
Talbot, A. N.
Taylor, Arthur P.
Taylor C. Marshall.
Taylor-Wharton Iron and Steel Co.,
J. H. Hall.
Thompson, Sanford E.
Tidewater Portland Cement Co.,
F. Guenther, Jr.
Titanium Alloy Manufacturing Co.,
N. Petinot.
Topping, W. S.

Tretch, William J.
Turner Co., J. Spencer,
    C. S. Cook.

U

Unger, J. S.
United Gas Improvement Co.,
    W. H. Fulweiler.
United States Gypsum Co.,
    Virgil G. Marani.
United States Rubber Co.,
    A. A. Somerville.
Universal Portland Cement Co.,
    B. F. Affleck.

V

Vacuum Oil Co.,
    Florus R. Baxter.
Van Gundy, C. P.
Vassar, H. S.
Veitch, F. P.
Victor Talking Machine Co.,
    Edwin F. Hicks.
Voorhees, S. S.
Vrendenburgh, Watson, Jr.

W

Wagner, Samuel T.
Walker, Percy H.
Walker, William H.
Walter, L. W.
Ware, E. E.
Waring, F. M.
Warner-Quinlan Asphalt Co.,
    William C. Monsell.
Warren, John B.
Warwick, C. Laurence.
Webster, George S.
Webster, W. Reuben.
Welty, H. T.
Western Electric Co.,
    A. H. Vorum.
Westinghouse Air Brake Co.,
    H. C. Loudenbeck.
Westinghouse Church Kerr and Co.,
    Cloyd M. Chapman.
Westinghouse Electric and Manufacturing Co.,
    C. E. Skinner.
White, Albert E.
White, G. D.
Wickhorst, M. H.
Wig, Rudolph J.
Wight, Frank C.
Wiley, W. O.
Wille, H. V.
    H. P. Austin.
Williams, J. P. J.
Wilson, Edwards F.
Wilson, J. J.
Wilson, Percy H.
Wiltsee, W. P.
Wise, Guy.
Wood, Edwin T.
Wood, Walter.
Wood Iron and Steel Co., Alan,
    W. A. Cooper.
Woodroffe, G. H.
Worcester, J. R.
Wormeley, P. L.
Worth Brothers Co.,
    E. T. Ickes.

Y

Yegge, C. Fred.
York Manufacturing Co.,
    C. H. Ehrenfeld.
Young, C. D.
Young, J. B.

Z

Zeleny, Frank.

AMERICAN SOCIETY FOR TESTING MATERIALS.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

PROCEEDINGS.

The Society is not responsible, as a body, for the statements and opinions advanced in its publications.

THE WORK OF COMMITTEES.

ANNUAL ADDRESS BY THE PRESIDENT, MANSFIELD MERRIMAN.

From our parent, The International Association for Testing Materials, we have inherited the method of doing work by committees. In 1882 Bauschinger, Tetmajer, Martens and others met at Munich to consider how uniformity in methods of testing could be promoted. In the ten following years four other meetings of these conferees were held and their reports attracted wide attention, so that the movement assumed an international character, and in 1895 a Congress was held at Zurich where the International Association was formally organized. Its object was declared to be "the development and unification of standard methods of testing for the determination of the properties of materials of construction and of other materials, and also the perfection of apparatus for that purpose."

Before the organization of the Association, the conference held at Vienna in 1893 had begun detailed work by the appointment of twenty committees in technical subjects, and reports from some of these were presented to the Zurich Congress of 1895. This work has been continued until the present time, over fifty technical committees having been constituted, some of which have rendered final reports and been dissolved. At the New York Congress of 1912 reports from several of these committees were received and discussed. At the present time there are 35 international committees upon which are 43 American members, but unfortunately their activities have been suspended since the beginning of the European war.

The work of these international committees has related almost entirely to methods of testing materials, thus closely adhering to the objects of the Association as set forth in the statutes of 1895. The plan of procedure, apparently, has been for the chairman to collect facts and opinions, occasionally to ask questions of the members, and to prepare a report which expresses almost entirely his personal conclusions. Meetings of these committees seem to have been very infrequent. The reports have rarely given specifications for the testing of materials, but have dwelt rather on the principles involved, the results of tests, and the kinds of apparatus which have been proposed or used. In only a few instances can it be said that one of these reports has carried with it the authoritative approval of the International Association or indeed of the committee itself.

After the American Section of the International Association was organized, in June, 1898, one of its tasks was to complete the American representation on the international committees. Accordingly, in the following January, when the number of members of the Association was 1526, of whom 106 were resident in the United States, the membership of the twenty international committees included 37 Americans. At the same time there were appointed four technical committees of the American Section, one on specifications for steel, one on impact tests, one on the heat treatment of iron and steel, and one on the relation between chemical composition and physical properties of iron and steel. The Committee on Impact Tests presented a valuable report which was published in October, 1899. The Committee on Specifications began its work early in 1899, held many meetings, enlarged its membership and prepared ten specifications for steel and wrought iron which were published in May, 1900, and adopted by letter ballot of the American Section three months later.

It has been a matter of surprise to find, in looking up the history of our Society, what a rapid development of committee work took place in those early years. The Committee on Steel under the efficient direction of its chairman, William R.

Webster, introduced indeed those principles and methods which have formed the basis of all work subsequently done. These methods appear to have been the following: (1) frequent meetings of the committee, (2) collection and systematic tabulation of the practice of leading engineers, consumers and producers, (3) the organization of sub-committees dealing with special phases of the subject, (4) submission to each member of the committee of proofs of the report and proposed specifications, (5) letter ballot of the committee thereon, (6) discussion at an annual meeting of the American Section, (7) revision if rendered necessary by action of the annual meeting, (8) submission of the specification to a letter ballot of all the members. In this manner, said Mr. Webster on May 1, 1900, there should be produced "representative specifications that will be fair both to the manufacturer and the consumer, and that will come into general use in this country."

When this Society was formally organized in May, 1902, as an outgrowth of the American Section, these methods of committee work were adopted and have since been continued with certain modifications and improvements. It is my purpose to briefly discuss some of the principal features and results of this work. I shall deal only with the technical committees which prepare specifications and other standards, omitting entirely the work of the Executive Committee and the Nominating Committee. I shall use the word "specification" for the body of rules included under one general head; thus the 34 clauses or rules given in our Year-Book for Carbon-steel Rails I consider not as specifications but as together constituting a Specification for Carbon-steel Rails.

The specifications proposed in 1900 by the American Section and all those issued by this Society, differ materially from those of the International Association in that they are complete for the use of both producers and consumers, instead of relating mainly to methods of testing. As a basis in their preparation, committees have taken the leading existing specifications. At the very start in January, 1900, it was required that the membership of a technical committee should be equally divided between producers and consumers, and this rule has since been closely followed, the consumers being usually in a slight majority. It must be confessed, however, that this practice has caused the original aim of the International Association—to establish standard methods of testing—to be lost sight of to a considerable extent. A few committees have indeed given details of tests for special materials, and our Committee E-1 has formulated methods for physical tests of steel, but it seems desirable that further work in this direction should be done. The main difficulty here seems to be to devise methods that shall be rapid and cheap as well as precise.

Prior to the year 1900 other societies had done valuable work through committees. Especially may be mentioned the reports of committees of the American Society of Civil Engineers, several of which related to materials. For instance, a Committee on Uniform Tests of Cements, appointed in 1880, made a preliminary report in 1884 which was discussed by the Society and referred back to the committee; in January, 1885, majority and minority reports were presented which were ordered to be printed. The differences between these reports were, however, adjusted, so that in November, 1885, a final report signed by all the members of the committee was published. This valuable report contained a specification for testing cement which has formed the basis for all work subsequently done in that direction in this country.

Work is more efficiently done by a committee than by a general meeting of a society because the committee can be constituted of experts who need not waste time on unessentials. The size of a committee is of some importance; when the membership is large it is difficult to secure a satisfactory attendance at meetings and many will not take the trouble to express their opinions in writing. The real work of a large committee is usually done by a few of its members. Maybe about twelve is the number which generally produces the most satisfactory results. Yet the nature of the problem under consideration should have much to do with the number of men who are appointed to solve it. In many cases sub-committees may be constituted to deal with divisions of the problems subject to certain general principles which govern them all.

Our Society has now actively at work 37 committees, and 15 of these have 89 sub-committees. These are classified under five groups: A, designating iron and steel; B, non-ferrous metals; C, cement and concrete; D, miscellaneous materials; and E, miscellaneous subjects. The largest committee is A-1 which has 97 members, the smallest is E-4 which has four members. The following shows the number of committees, members thereof, and sub-committees as they existed at the time of publication of the Year-Book of 1915:

GROUP.	COMMITTEES.	MEMBERS.	SUB-COMMITTEES.
A....................	8	255	25
B....................	2	39	4
C....................	10	202	32
D....................	11	339	36
E....................	6	78	2

Altogether the membership of the 37 committees is 913, which is nearly one-half the membership of the Society, but since some men are on two or more committees it is probable that only about one-third of our members are engaged in committee work.

The constitution provides that a corporation, a firm, a technical or scientific society, a teaching faculty, or a library, may have active membership, and it is understood that these may have all the privileges of an individual member, except that of holding office. At the time of the issue of the last list, there was a total membership of 1902, of which about 16 per cent were firms and corporations. But on the rolls of committees the percentage is much higher, it being, for instance, 51 per cent in the large Committee A-1. Since companies usually defray the expenses of their representatives to committee meetings, it appears that their attendance is better than that of individual members, and that thus the influence of firms and corporations is greater than that of individuals. No objection can be made to this, for companies, whether they be producers or consumers, are working not only for themselves but for their customers.

It is undoubtedly due to corporations and firms that the committee work of the Society is conducted so cheaply. Owing to the large volume of their trade it is necessary for companies to make numerous tests and to carry on considerable research, the results of which are freely communicated to committees by their representatives. During the period of two years from January 1, 1914, to December 31, 1915, the total expenses of all technical committees, including joint conferences, were $2440.16, which is nearly 5 per cent of the total disbursements for all expenses of the Society during the same period.

In order to compare the cost of committee work with the outlay for other items, all expenses may be classified under six groups: (1) Publications; (2) Salaries; (3) General expenses, including audits of accounts, rent, insurance, postage, express, and a small item of unclassified expenses; (4) Technical and standing committees; (5) Annual meeting; (6) Mileage of members of the Nominating Committee. The following table gives the expenses in each of these groups, in percentages of the total disbursements for all expenses. In preparing this table those expenses of joint committees which have been paid by us are included under group (4), while all disbursements charged to the International Association have been excluded.

	FOR YEAR ENDING		
	DEC. 31, 1913.	DEC. 31, 1914.	DEC. 31, 1915.
(1) Publications	68.77	64.90	60.65
(2) Salaries	19.68	23.78	27.60
(3) General Expenses	4.76	4.41	5.17
(4) Technical Committees	4.73	5.62	4.22
(5) Annual Meeting	2.06	0.84	1.99
(6) Nominating Committee	0.00	0.45	0.37
	100.00	100.00	100.00

A comparison of these figures with similar ones derived from the published accounts of other engineering societies would scarcely be proper in this address. Moreover, the larger national societies expend money for interest on debts or for rents, and are subject to expenses for the maintenance of their rooms and libraries, so that it would not be easy to make a satisfactory comparison. It may be said, however, that I have been able to find only one year in the records of one of those societies which furnishes a percentage for the expenses of committee work apparently greater than the largest above given.

In order to ensure efficient work by committees various rules and regulations have been adopted which are printed in the Year-Book. These relate to organization, officers, sub-committees, meetings, reports, and the procedure governing the adoption of standards. Correspondence is to be conducted on official stationery furnished by the Secretary-Treasurer. Expenses for postage will be refunded by the same officer. Nothing is said about expenses for expressage, telegraphing, or telephoning, nor about expenses incurred by members of a committee in attending meetings; these in general seem to be covered by the rule that "expenses for items other than postage will not be assumed by the Society unless such expenditures were incurred in pursuance of the previous authorization of the Executive Committee." This implies that each committee should submit an annual budget of its prospective expenditures, yet such budgets are, I think, very infrequent. Committees are not allowed to pay salaries or fees to any of their officers or members. Assistance in connection with research work may be paid for, provided funds for such compensation shall have previously been deposited with the Executive Committee. In a few cases such funds for the use of committees have been contributed by manufacturers.

The main responsibility for these rules and regulations rests with Committee E-5, composed of the chairmen of all standing committees. After several years of consideration these rules are now in good shape, and under them all standing committees are now acting. In this manner tolerably uniform methods of procedure have been established which conduce toward efficient work and to the production of satisfactory standard specifications, tests, methods, and definitions.

A word here ought to be said regarding the Regulations Governing the Form but not the Substance of Standards, which have now been in force for four years. These relate to arrangement and subdivision, and to typography; also to the terms, spelling, abbreviations, etc., as determined by the most approved practice of engineering societies. The very clear typography and the consistent arrangement of our published volumes result from a faithful adherence to these regulations.

After months and perhaps years of discussion a committee formulates the standard which it recommends. Then a letter ballot of the committee is taken and a majority is always in favor of approval. Nevertheless a considerable minority constitutes a force which may perhaps prevent the Society from sending the standard out for letter ballot of the entire membership; in fact opposition from members not on the committee has sometimes produced this result. Hence a standard recommended by a committee must be one that has been most carefully considered and which harmonizes all opinions and interests. The letter ballot of the Society is, I believe, invariably in favor of adopting the standard recommended by the committee; hence such adoption is of doubtful value unless the members who vote certify that they have carefully considered the matter and regard themselves as fully competent to express approval or disapproval.

The manner of publication of adopted standard specifications, tests, methods, and definitions will now be briefly considered. When specifications were few and papers many, standards were naturally printed among the papers, but as standards became more numerous separate publication was introduced. The plan of annual publication in a Year-Book, followed since 1910 by this Society, has the advantage of bringing together all the adopted standards, so that a purchaser of the latest edition is sure as to what is in force; this method may appear to some to be unnecessarily expensive since certain standards are thus reprinted year after year without change. Moreover, if the number of standards continues to increase in the future as in the past, the Year-Book will become a thick and heavy volume.

Our first Year-Book, that for 1910, contained 28 specifications which filled 127 pages. The Year-Book for 1915 contains 88 adopted and 22 tentative standards which fill 622 pages; two-thirds of the 85 adopted standards are reprinted from the volume of 1914. The latest Year-Book being complete, the previous volumes are of little value except from a historic point of view. Regarding tentative standards, it has been doubted if they should appear at all in the Year-Book, and recently it has been decided by the Executive Committee that hereafter they shall be published in the Proceedings in connection with the discussions thereto pertaining. The following shows the number of adopted standards in the three latest Year-Books:

		YEAR-BOOK FOR	
GROUP	1913.	1914.	1915.
A	43	48	56
B	7	7	7
C	3	4	8
D	10	10	16
E	1	1	1
Total	64	70	88

The circulation of our standard specifications, tests, methods and definitions, extends far beyond our membership. Many are copied, in whole or in part, in text-books and reference works. Extracts or abstracts have appeared in periodical literature and in pamphlets issued by producers. They have exerted an influence on the specifications of other societies, especially when joint committees have been constituted. Copies of the Year-Book have been sold to non-members and copies of separate specifications to manufacturers and others. A volume containing selected specifications has been furnished to engineering students. Rights to print certain specifications in full have been sold to a few producers, and the income to the Society from this source in 1915 was almost as large as all the expenses of all technical committees. The following figures, kindly furnished by Secretary Marburg, give more detailed information for the last three fiscal years regarding the circulation of our adopted standards in the English language, the numbers in parentheses being the number of standards in the volume:

		FOR YEAR	
	1913.	1914.	1915.
Copies of Year-Book	2 000 (64)	2 000 (70)	2 400 (88)
Copies of students' issue	400 (24)	350 (33)	350 (36)
Copies of special volume	500 (20)	...	...
Copies of separate standards	3 394	4 585	4 999
Copies issued by producers:			
Steel volumes	20 000 (7)	20 000 (7)	10 000 (10)
Steel pamphlets	....	2 500 (11)	5 500 (14)
			500 (23)
Steel pamphlets	....	1 000 (2)	2 500 (4)
Steel specifications	.....	16 000	16 000
Lime specifications	....	....	15 000
Cement specifications	13 000	12 000	15 000

All of these which were issued in 1913 and 1914 have been sold and also a large part of the issues of 1915. Multiplying the number of copies of each volume by the number of standards therein contained, and adding thereto the number of copies of separate specifications, there is found in round numbers,

For 1913	304 000 copies
For 1914	353 600 copies
For 1915	467 300 copies

or a grand total of 1,124,900 copies of adopted standards printed or issued in three years. These figures do not include any tentative standards or any copies of standards contained in the preprints distributed prior to and at the annual meetings.

The report of the Executive Committee which is presented at this meeting shows that the receipts from the sale of rights to print certain Standards of the Society are now $1050.00 per year, while the total expenses for all standing committee work in 1915 were $1090.25. Hence the profit derived from the sale of the work of our committees now practically equals the cost of that work to the Society. In view of this it seems that larger allowances should be made to committees, these of course being assigned in pursuance of well-matured plans and based on budgets which have been approved by the Executive Committee. Our increased income from the recent increase in annual dues may now well permit larger expenses for continuing that work which has in the past established the reputation of the Society.

The influence of our standards upon foreign countries has been constantly growing. In 1913 a special volume containing twenty specifications for steel products was issued, each specification being given in the English, French, German and Spanish languages. Of this volume 500 copies were printed, all of which have been distributed and sold. Also 4500 pamphlets containing the specifications in the foreign languages were printed. Since our last annual meeting arrangements have been made with the Department of Commerce by which such standards as have an important bearing on the export trade of the United States will be translated free of expense to the Society, be distributed to consular offices throughout the world, and also be made available at moderate prices to American manufacturers and others. This work is now in progress, some forty-three or more standard specifications having been already translated into Spanish, and it is expected that translations into the Portuguese, French, and Russian languages will also be made.

A word of warning may here be uttered against the idea that engineering specifications, methods, tests and definitions can really be made standard in the strict sense of the word, for complete standardization often means stagnation. Standard tools are those which in the same factory allow of no variation, and the expense of altering such tools has been a great obstacle in the adoption of a rational system of measures in this country. Standard methods of testing, widely adopted by manufacturers, may result in certain standard tools for preparing specimens and in standard apparatus for making tests. Thus a material alteration in these may bring an expense upon producers, and hence, on account of the monetary loss apparently involved, many will object to changes which have been demonstrated to be necessary in order to furnish the most reliable knowledge of materials. It seems to me that no standards adopted by this Society should be so unyielding that they cannot be altered when the advancement of science so requires. Only physical standards of weights and measures may properly be unalterable as far as possible.

In conclusion it may be said that every member of this Society should feel highly gratified at the results of the work of its technical committees. Numerous tests, discussions and reports have brought to them new light on the problems of the mechanics and strength of materials, while the practice of manufacturers has been studied in order that costs of production may be lessened and better materials be delivered to consumers. The work of our committees has been done efficiently and economically. As a result standards have been adopted which have brought the interests of producers and consumers in this country into harmony, which have become favorably known abroad, and which, as time rolls on, will undoubtedly be of great benefit to the industrial interests of the United States.

ANNUAL REPORT OF THE EXECUTIVE COMMITTEE.

Publications.—The regular publications issued during the past year again exceed in volume those of any earlier year, the comparison for the past three years being as follows:

	1913–14. Pages.	1914–15. Pages.	1915–16. Pages.
Proceedings	1141	1162	962
Year-Book	401	500	757
Membership Pamphlet	190	219	247
Total	1732	1881	1966

The 1915 Year-Book contains 18 new, 10 revised and 22 new tentative standards as compared with the 1914 Year-Book, or a total of 88 standards and 22 tentative standards, the contents representing an increase of over fifty per cent compared with the previous year. Of the Proceedings 967 pages were preprinted (as against 928 pages for the previous year), of which 891 pages (as against 668 pages for the previous year) were distributed among the membership at large in advance of the last annual meeting. For the first time every committee report was available in printed form at the last annual meeting. Ten circulars to members aggregating 44 pages have also been issued during the past year.

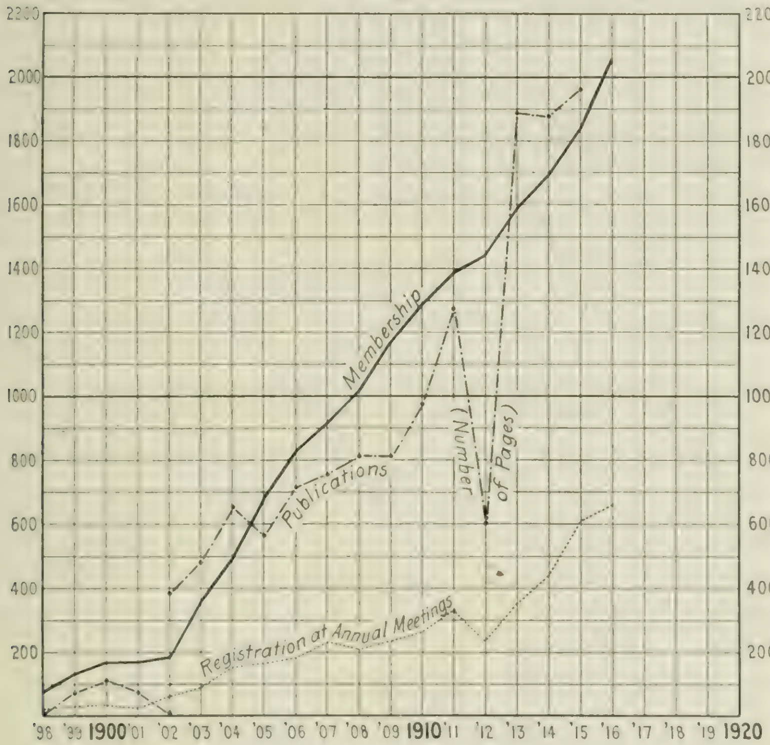
The policy of preprinting committee reports and papers was inaugurated three years ago with a view of stimulating discussion, especially on the part of members unable to attend the annual meetings. The effect of this policy is shown by the following analysis, from which it will be seen that there has been some retrogression during the past year:

Year.	Discussion (pages).			Proceedings, Total Pages.	Ratio of Discussion to Total Pages, per cent.
	Verbal.	By Letter.	Total.		
1913	121	68	189	1141	16.6
1914	153	62	215	1162	18.5
1915	80	55	135	962	14.0

Membership.—The membership at the last annual meeting was 1842. Since then 413 applications for membership have been approved as compared with 298 during the previous year. The losses by death number 17, namely:

H. B. Anderson	July 13, 1915
A. L. Bowman	June 3, 1915
C. H. Cartlidge	June 14, 1916
L. V. Clark	December 28, 1915
E. L. Corthell	May 16, 1916
P. J. Dalton	January 17, 1916
J. A. Holmes	June 13, 1915
H. A. Hottenroth	February 2, 1916
L. E. Hunt	January 9, 1916
C. M. Mills	February 15, 1916
G. E. Perley	March 9, 1916
F. W. Scarborough	December 24, 1915
C. C. Schneider	January 8, 1916
T. B. Stillman	August 10, 1915
Wirt Tassin	November 2, 1915
H. S. Turner	June 22, 1915
T. D. West	June 18, 1915

The number of resignations is 102, and 66 members have been dropped for non-payment of dues, the former number being 27 and the latter 5 in excess of the corresponding number for the previous year. The total losses for the year from all causes number 185, and the net increase in membership for the year is 228, as compared with 155 for the previous year, and with an average net annual increase of 112 for the preceding five years. The total membership of the Society is now 2070, of whom 210 are Junior Members. Considering that the membership dues were increased fifty per cent at the beginning of the current fiscal year, the fact that the growth of the Society has been markedly greater for the past twelve months than for any corresponding earlier period may be regarded as substantial evidence of the firm position which the Society has attained.



NOTE.—The initial curve for publications (1898–1902) refers to the publications of the American Section of the International Association for Testing Materials. The marked drop for 1912 in the publications and registration at annual meetings curves is due to the fact that the Sixth Congress of the International Association was held in New York in September, 1912, and that the activities of the American Society for that year were accordingly restricted to committee reports and administrative business.

Standing Committees.—The activities of the standing committees, which have always been such a notable factor in the achievements of the Society, have shown no abatement during the past year. In addition to the results which will be reported by committees at this annual meeting, much work has been done by other committees who are not yet prepared to report definite conclusions.

Committee A-10 on Hardness Tests has been discontinued with its consent as an independent committee, and is now merged with Committee E-1 on Methods of Testing, of which it is a sub-committee.

Committee D-12 on Petroleum Products has been discontinued by the Executive Committee on the recommendation of its acting chairman.

Committee D-3 (formerly E-4) on Methods of Sampling and Analysis of Coal, which had supposedly presented its final report last year, has been continued on its own recommendation, for reasons indicated in its report at this meeting.

While no new committees have been created during the past year the subject of metallic coatings for metals has been referred to Committee A-5 on Corrosion of Iron and Steel, and a sub-committee to deal specifically with that subject is now in course of organization.

Since the last annual meeting the following subscriptions towards the conduct of research work by various standing committees have been contributed to the treasury of the Society:

Committee A-5 on Corrosion of Iron and Steel	$989.96
Committee C-1 on Cement................	6 150.00
Committee C-9 on Concrete Aggregates.....	2 500.00
Committee C-10 on Hollow Building Tile...	100.00
Total...........................	$9 739.96

The Regulations Governing Standing Committees provide that any recommendations affecting standards must be sent in printed form to every member of the Society not less than four weeks before the annual meeting at which these recommendations are to be presented. This regulation has been strictly observed in connection with the matter listed below, with the exception of the items distinguished by an (*), concerning which the reports were not received in time to make this feasible.

I. PROPOSED NEW STANDARDS.

NOTE—With the exception of the six Standards recommended by Committee D-4, the following Standards have all been published in the 1915 Year-Book for one year as tentative. Of these six, the two distinguished by a (†) are now presented for the first time, while the remaining four were reported in 1914 and printed in the Proceedings.

Recommended by Committee A-1 on Steel:

For Carbon-Steel Bars for Vehicle and Automobile Springs.
For Silico-Manganese-Steel Bars for Automobile and Railway Springs.
For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs.
For Helical Springs for Railways.
For Elliptical Springs for Railways.
For Alloy-Steel Forgings.[1]
For Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars.

Recommended by Committee A-3 on Cast Iron:

Methods for Sampling and Analysis of Pig and Cast Iron.

Recommended by Committee B-1 on Copper Wire:

For Bare Concentric-Lay Copper Cable: Hard, Medium-Hard or Soft.
For High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity.

Recommended by Committee D-3 on Analysis of Coal:

Methods for Laboratory Sampling and Analysis of Coal.

Recommended by Committee D-4 on Road Materials:

Test for the Determination of Apparent Specific Gravity of Homogeneous Coarse Aggregates.
†Form of Specifications for Certain Commercial Grades of Broken Stone.
Method for Making a Mechanical Analysis of Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete.

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[1] To be combined, if adopted, with the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18–14).

Method for Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete.
Method for Distillation of Bituminous Materials Suitable for Road Treatment.
†Method for the Determination of Softening Point of Bituminous Materials Other than Tar Products.

Recommended by Committee D-5 on Coal:

Method for Sampling of Coal.

Recommended by Committee D-6 on Coke:

Specifications for Foundry Coke.

II. PROPOSED NEW TENTATIVE STANDARDS.

Recommended by Committee A-1 on Steel:

For Steel Track Spikes.
For Steel Screw Spikes.
For Steel Tie Plates.
For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements.
For Elliptical Springs for Automobiles.
For Boiler and Firebox Steel for Stationary Service.

Recommended by Committee B-2 on Non-Ferrous Metals:

For Copper Plates for Locomotive Fireboxes.
For Copper Bars for Locomotive Staybolts.
For Seamless Copper Boiler Tubes.
For Seamless Brass Boiler Tubes.
For Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings, and Finished Car and Tender Bearings.

Recommended by Committee C-1 on Cement:

For Compressive Strength of Portland Cement Mortar—Specifications and Methods of Tests.[1]

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[1] To be included, when adopted, in the proposed American Specifications and Methods of Tests for Portland Cement.

Recommended by Committee C-11 on Gypsum:

*For Uncalcined Gypsum.
*For Calcined Gypsum.
*For Gypsum Plasters.
*Methods for Testing Gypsum and Gypsum Products.
*Definitions of Terms Used in the Gypsum Industry.

Recommended by Committee D-4 on Road Materials:

Definitions of Terms Applicable to Materials Relating to Roads and Pavements.[1]

Recommended by Committee D-6 on Coke:

Methods for Laboratory Sampling and Analysis of Coke.

Recommended by Committee D-7 on Timber:

*For Structural Douglas Fir Bridge and Trestle Timbers.
*For Wooden Paving Blocks.

Recommended by Committee D-11 on Rubber Products:

For $2\frac{1}{2}$, 3 and $3\frac{1}{2}$-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use.

Recommended by Committee D-13 on Textile Fabrics:

General Methods for Testing Cotton Fabrics.[2]
Tests for Automobile Tire Fabrics. *
Tests for Fabrics for Use in Hose, Belting and Similar Articles.

III. PROPOSED REVISION OF STANDARDS.

NOTE.—The committees concerned recommend that the revisions of the following Standards be referred at once to letter ballot of the Society instead of being published as tentative revisions for one year (or two years if the plan of biennial publication recommended by the Executive Committee should be approved).

Recommended by Committee A-1 on Steel:

For Structural Steel for Bridges (A 7–15).
For Structural Nickel Steel (A 8–14).

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[1] To be included, when adopted, in the Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements (D 8–15).

[2] These methods contain the subject matter of the Tentative Tests for Automobile Tire Fabrics published in the 1915 Year-Book, p. 574.

* It was not feasible to distribute these proposed tentative standards four weeks in advance of the annual meeting.

For Structural Steel for Buildings (A 9–14).
For Structural Steel for Locomotives (A 10–14).
For Structural Steel for Cars (A 11–14).
For Structural Steel for Ships (A 12–14).
For Carbon-Steel Bars for Railway Springs (A 14–14).
For Carbon-Steel and Alloy-Steel Forgings (A 18–14).
For Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars (A 19–14).
For Carbon-Steel Forgings for Locomotives (A 20–14).
For Cold-Rolled Steel Axles (A 22–14).
For Wrought Solid Carbon-Steel Wheels for Steam Railway Service (combination and revision of Standard Specifications A 23–12 and A 24–12).
For Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–13).
For Steel Tires (A 26–14).
For Steel Castings (A 27–14).
For Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes (A 28–13).
For Boiler and Firebox Steel (A 30–14).

Recommended by Committee A-2 on Wrought Iron:

*For Lap-Welded Iron Boiler Tubes (A 38–12).

Recommended by Committee B-2 on Non-Ferrous Metals:

For Spelter (B 6–14).

Recommended by Committee C-1 on Cement:

For Portland Cement—American Specifications and Methods of Tests (C 1–09).

Recommended by Committee C-6 on Drain Tile:

For Drain Tile (C 4–14).

Recommended by Committee D-1 on Preservative Coatings:

For Purity of Raw Chinese Wood Oil (D 12–15).

Recommended by Committee D-4 on Road Materials:

Test for Penetration of Bituminous Materials (D 5–11).
Test for Loss on Heating of Oil and Asphaltic Compounds (D 6–11).

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* It was not feasible to distribute these proposed revisions four weeks in advance of the annual meeting.

Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregate Used in Cement Concrete (D 7–11).

Recommended by Commiitee E-1 on Methods of Testing:

Methods for Testing (E 1-15).

IV. PROPOSED TENTATIVE REVISIONS OF STANDARDS.

Recommended by Committee A-6 on Magnetic Properties:

Tests for Magnetic Properties of Iron and Steel (A 34–14).

V. TENTATIVE STANDARDS TO BE CONTINUED.

Recommended by Committee C-4 on Sewer Pipe:

*Recommended Practice for Laying of Sewer Pipe (in amended form).

Recommended by Committee D-7 on Timber:

*Methods for Sampling and Analysis of Creosote Oil (in amended form).

Recommended by Committee D-1 on Preservative Coatings:

Tests for Distillation of Paint Thinners Other than Turpentine (in amended form).

Tests for Shellac (in amended form).

Methods for Routine Analysis of White Pigments.

During the year many changes have been made in the Regulations Governing Standing Committees by joint action of Committee E-5 and the Executive Committee. These changes appear in detail in the report of Committee E-5 and are therefore not repeated here.

Matters Referred to the Executive Committee by Previous Action of the Society.—1. At the Seventeenth Annual Meeting (1914) the following resolution was adopted:

> WHEREAS, In the report of Committee C-6 on Standard Tests and Specifications for Drain Tile, presented at this meeting, it is stated in substance that "Satisfactory and definite specifications for quality of tile" require (*a*) Standard Specifications for Strength Tests and (*b*) the Definition of Practice in Tile Drain Design and Construction, and

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* It was not feasible to distribute these tentative standards four weeks in advance of the annual meeting.

WHEREAS, The proposed standards and practice embodied in the report of Committee C-6 were referred without debate to letter ballot of the Society, and

WHEREAS, This is the first instance in which proposed standard specifications of the Society are based on prescribed engineering design and construction, and

WHEREAS, It is the sense of this meeting that matters of engineering design and construction do not, in general, properly fall within the province of the Society, be it therefore,

Resolved, (*a*) That the Executive Committee be hereby instructed to consider the general questions involved in such a departure from the previous policy of the Society, and (*b*) that the Executive Committee and Committee C-6 be jointly instructed to consider the particular questions involved in this instance, and that the findings be reported to the Society at the next annual meeting.

The last annual report of the Executive Committee contains the following reference to the foregoing resolution:

The Executive Committee concurs in the view expressed in the preamble to the above resolution that matters of engineering design and construction do not in general properly fall within the province of the Society and it has been informed that this is also the sense of Committee C-6. In preparing the proposed Standard Tests and Specifications for Drain Tile last year Committee C-6 considered it difficult, if not impossible, however, to adhere to that principle without detracting seriously from the value of the specifications. The committee proposes to subject these specifications to a critical revision in the light of further tests now in progress, and with a view of seeking the best means of minimizing reference to matters of engineering design and construction. It accordingly seems desirable that this phase of the resolution should not be reported on pending further consideration on the part of the Executive Committee and Committee C-6, after the proposed revision of the specifications has been completed in at least a preliminary way.

During the past year the Executive Committee has given careful consideration to this important matter and, with the concurrence of Committee E-5 on Standing Committees, the following paragraph has been added to the Regulations Governing Standing Committees:

In the preparation of proposed Standards the consideration of matters of engineering design or construction shall not in general be regarded as falling within the province of the Society. If, however, it should appear to a given committee that the consideration of such matters is, for special reasons, indispensable in specifications designed to cover the customary relations between the producers and consumers of a given product, then reference to such matter in proposed specifications for that product shall be permitted within the scope necessary for the particular purpose above stated. Proposed Standards embodying features of the character in question shall be submitted by the committee concerned to the Executive Committee for consideration and comment not later than the quarterly meeting immediately preceding the annual meeting at which the proposed Standards are to be presented.

Committee C-6 on Drain Tile has entirely rewritten the present Standard Specifications for Drain Tile with a view of (1) bringing them into better conformity with the Standards of the Society as to form, and (2) reducing the references to pipe laying specifications to the smallest limit compatible with practical requirements governing their use.

The chairman of Committee C-6 presented in person to the Executive Committee a detailed statement covering these matters from the standpoint of his committee in pursuance of which the Executive Committee has decided that the proposed revised Standard Specifications for Drain Tile, which will be presented at this annual meeting, be approved in so far as the above stated principles are involved. It was the sense of the Executive Committee, as further expressed at that time, "that it is inexpedient to authorize Committee C-6 at this time to proceed with the framing of proposed standard specifications for, or recommended practice governing the laying of drain tile, but that it be understood that if non-official individual efforts on the part of the members of Committee C-6 to have this matter taken up by other organizations should fail the question may be reopened at some future time."

2. By action at the last annual meeting the proposed Tentative Recommended Practice for Laying of Sewer Pipe, presented by Committee C-4 on Clay and Cement Sewer Pipe, was accepted for publication among the Tentative Standards in the Year-Book, with the understanding that the committee which had under consideration the question of introducing matters of engineering design and construction in the Standards of the Society, as exemplified in the Standards introduced the year before by Committee C-6 on Drain Tile, be increased by the addition of representatives of Committee C-4, this committee consisting then of the Executive Committee and representatives of Committee C-6.

At a meeting of the Executive Committee at which Committee C-4 was represented it was the judgment of the Executive

Committee that the present Tentative Recommended Practice for Laying of Sewer Pipe should be regarded as not properly falling within the province of the Society, but that if that committee desired to proceed with the preparation of proposed Standard Specifications for Sewer Pipe and, following the precedent of Committee C-6, will include in such proposed specifications what may be regarded as indispensable references to pipe laying to give these specifications the desired practical effect, these specifications shall be submitted to the Executive Committee for approval as to such features not later than the quarterly meeting immediately preceding the annual meeting at which they are to be presented, as provided in the above addition to the Regulations Governing Standing Committees.

As will be seen from the report of Committee C-4 to be presented at this annual meeting, that committee is not yet prepared to present proposed Standard Specifications for Sewer Pipe, but its report contains certain proposed changes in the Tentative Recommended Practice for Laying of Sewer Pipe.

3. By resolution at the last annual meeting the Executive Committee was requested "to confer with the Board of Direction of the American Society of Civil Engineers and suggest that they withhold from general publication the Joint Conference report until Committee C-1 on Cement has had a sufficient opportunity (not longer than one year) to consider the report."

In pursuance of a communication on this subject to the Board of Direction of the American Society of Civil Engineers that Board adopted the following resolutions which were reported to the Executive Committee.

"WHEREAS, The representatives of this Society appointed on the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement have, without an appropriation, and without reference to the officers of this Society or its Publication Committee, had a Report of some 145 pages printed, and

"WHEREAS, The Executive Committee of the American Society for Testing Materials unanimously agreed to inform the Board of Direction of the American Society of Civil Engineers that, in its judgment, it would be prejudicial to the best interests of the American Society for Testing Materials to give publicity to the Report under consideration, and suggested that the Board of Direction hold the publication of the Report in abeyance for a period not longer than one year, as stated in a letter from the Secretary-Treasurer of that Society, dated June 28, 1915, be it

> "*Resolved*, That whenever a Report of the Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement is presented by the representatives of this Society, it will be published under the supervision of the Committee on Publications on the part of this Society, provided that the expense of such publication be met jointly by this Society and the American Society for Testing Materials, and provided also that such publication is authorized by the American Society for Testing Materials."

4. A motion at the last annual meeting "that no specifications shall contain any discrimination between two or more materials unless such specifications contain a method of distinguishing these materials" was referred jointly to the Executive Committee and Committee E-5 on Standing Committees.

At a meeting of Committee E-5 this matter was, on motion, laid on the table and was so reported to the Executive Committee. At a subsequent meeting of the Executive Committee it was decided to be "inexpedient to approve this proposal because in some cases there are no known methods of distinguishing different materials without direct knowledge of their origin."

Finances.—In the last annual report of the Executive Committee considerable space was given to the discussion of the financial condition of the Society and the presentation of various remedial measures designed either to increase revenues or to curtail expenses. It was shown that the deficits at the close of successive fiscal years since 1912 had been increasing steadily and that the deficit at the end of 1914 was $5,332.96, representing an increase of $1,742.01 over the deficit at the close of the preceding fiscal year. It was also shown that, while at a moderate valuation of the assets in the way of accumulated publications—the net cost of which was estimated at $9,763.75 and the market value at full list prices at $32,549.50—the Society was technically solvent, yet the steadily growing deficit in the financial operations of the Society rendered the adoption of adequate remedial measures imperative. The financial conditions at the close of the fiscal years 1912–1915 inclusive, are shown at the end of the following report of the auditors, from which it is seen that the deficit at the close of the last fiscal year (1915) was $6,407.03, which represents an increase of $1,074.07, as compared with the deficit at the close of the preceding fiscal year.

REPORT OF AUDITORS FOR THE FISCAL YEAR JANUARY 1, 1915, TO DECEMBER 31, 1915.

JOHN HEINS & CO.,
PUBLIC ACCOUNTANTS AND AUDITORS.

PHILADELPHIA, January 6, 1916.

Mr. Edgar Marburg, *Secretary-Treasurer*,
American Society for Testing Materials,
Philadelphia, Pa.

Dear Sir:

We respectfully report that we have made an audit and examination of the books and accounts of your Society for the six months ended December 31, 1915 and report them to be correct, and that the accounts are in the same excellent condition as at our last examination.

We submit balance sheet as of December 31, 1915, as also a statement of operations for the twelve months then ended, schedules of accounts receivable, etc.

Respectfully submitted,
(Signed) JOHN HEINS & CO.

BALANCE SHEET—AS OF DECEMBER 31, 1915.

ASSETS.

Cash			$103.54
Accounts Receivable:			
Other than Members	$1 544.85		
Members for Publications	81.90		
Members for Dues	813.00		
		$2 439.75	
Less Reserve for uncollected Dues	$813.00		
" Members dues paid in advance	144.95		
		957.95	
			1 481 80
			$1 585.34

LIABILITIES.

Accounts Payable	7 933.54
Excess of Liabilities, December 31, 1915	$6 348.20[a]

In addition to the above cash the Treasurer has on hand the following Funds:

Committee A-5 on Corrosion of Iron and Steel	$1 713.68
Committee C-1 on Cement	2 956.00
Committee C-9 on Concrete Aggregates	205.95
International Association, Trust Account	1 739.57
Total	$6 615.20

[a] NOTE.—In addition to the above deficit of $6,348.20, there were submitted to us, after the books had been closed, bills aggregating $58.83, which will increase the total deficit to $6,407.03, as shown in statement headed "Conditions at Close of Fiscal Years 1912–15."

INCOME AND EXPENSES FOR TWELVE MONTHS ENDING DECEMBER 31, 1915.

INCOME.

Dues		$18 107.42	
Publication Sales		5 620.44	
Sales of Right to Reprint Standards		950.00	
Interest on Deposits		83.65	
			$24 761.51

EXPENSES.

Salaries (including Secretary-Treasurer's salary at the rate of $3 600 per annum)		$7 123.59	
Publication Costs		15 657.01	
Expenses, Secretary-Treasurer's office:			
Audits by public accountants	$87.50		
Rent and insurance, storage room	201.60		
Postage and expressage	428.67		
Miscellaneous expenses	616.13		
		1 333.90	
Expenses, Standing Committees		802.61	
Annual Meeting Expenses, net		514.30	
Expenses, Nominating Committee		94.77	
Joint Conference on Uniform Methods of Tests and Standard Specifications for Cement		287.64	
			25 813.82
Excess of Expenses			$1 052.31

CONDITIONS AT CLOSE OF FISCAL YEARS 1912–1915 INCLUSIVE.

Fiscal Year.	Cash Balance.	Unpaid Bills.			Accounts Receivable.[1]	Deficit.
		On Hand.	Not yet Received.	Total.		
1912	$1 216.47	....	$2 500.00	$2 500.00	$385.79	$897.74
1913	1 139.87	$4 621.37	771.64	5 393.01	662.19	3 590.95
1914	43.57	6 199.05	222.22	6 421.27	1 044.74	5 332.96
1915	103.54	7 933.54	58.83	7 992.37	1 481.80	6 407.03[a]

[1] Back dues not included.

[a] See further reference to this deficit on p. 63.

At a special meeting of the Executive Committee held prior to the 1916 annual meeting of the Society, it was decided to print in connection with this year's report, for purposes of comparison, the following financial statement from June 1, 1915, to June 1, 1916, in the same form as that published a year ago.[1]

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, pp. 59–60 (1915).

ANNUAL REPORT OF THE SECRETARY-TREASURER.

From June 1, 1915, to June 1, 1916.

RECEIPTS.

Membership dues	$28 429.32	
Sale of Publications	4 683.97	
Binding Proceedings	297.50	
Authors' reprints	356.25	
Sales of right to reprint specifications for one year	1 050.00	
Sale of certificates of membership	27.50	
Interest on deposits	73.79	
Sale of Electrotype plates, Vols. VI–XV, inclusive	321.65	
Committee D-1	70.53	
Unclassified receipts	34.75	
Total receipts	$35 345.26	
Cash balance, June 1, 1915	6 480.79	
		$41 826.05

DISBURSEMENTS.

Publications		$15 207.93	
Salaries (including Secretary-Treasurer's salary at the rate of $3600 per annum)		7 233.91	
Audits by public accountants		87.50	
Rent and insurance, storage room		201.60	
Expenses, Secretary-Treasurer's office:			
Postage and expressage	$509.60		
Miscellaneous expenses	698.75		
		1 208.35	
Expenses, standing committees		1 315.91	
Expenses, Nominating Committee		53.30	
Net expenses, Eighteenth Annual Meeting		514.30	
Engrossing certificates of membership		12.00	
Joint Conference on Methods of Tests and Standard Specifications for Cement		287.64	
Refund of excess remittances		27.50	
Unclassified disbursements		9.25	
Total disbursements		$26 159.19	
Cash balance, June 1, 1916		15 666.86	
			$41 826.05

ANALYSIS OF DISBURSEMENTS FOR ACCOUNT OF PUBLICATIONS.

	CLERICAL SERVICES.	PRINTING AND MAILING.	TOTAL.
Membership pamphlet	$110.45	$795.80	$906.25
Year-Book	73.92	4 157.61	4 231.53
Proceedings	316.13	5 504.62	5 820.75
Circulars to members	......	667.86	667.86
Preprints	......	2 431.20	2 431.20
Reprints	......	448.49	448.49
Specifications	0.50	165.75	166.25
Miscellaneous	29.64	505.96	535.60
	$530.64	$14 677.29	$15 207.93

COMMITTEE FUNDS.

COMMITTEE A-5.

Cash balance, June 1, 1915	$2 500.00		
Receipts	42.79		
		$2 542.79	
Disbursements		1 570.31	
Cash balance, June 1, 1916			$972.48

COMMITTEE C-1.

Receipts		$5 710.81	
Disbursements		1 633.09	
Cash balance, June 1, 1916			4 077.72

COMMITTEE C-9.

Cash balance, June 1, 1915	$748.65		
Receipts	2 511.58		
		$3 260.23	
Disbursements		3 076.52	
Cash balance, June 1, 1916			183.71

COMMITTEE C-10.

Receipts		$100.00	
Cash balance, June 1, 1916			100.00

COMMITTEE D-1.

Cash balance, June 1, 1915		$70.53	
Disbursements		70.53	
			......
Total cash balance, Committee Funds, June 1, 1916			$5 333.91

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

(Dues for 1915 held in trust pending action of the I.A.T.M. Council, after the close of the European War.)

Cash balance, June 1, 1915	$1 746.46		
Receipts (interest on deposits)	22.43		
		$1 768.89	
Refunds to members on request		20.00	
Cash balance, June 1, 1916			$1 748.89

Action at the last annual meeting on the proposed amendment of the by-laws relative to finances "was deferred at the first session pending a report from a committee consisting of the members of the incoming and outgoing Executive Committees, which was charged to consider the financial question in all its phases and to report its findings to the Society at the opening of the fifth session, the expressed sense of the meeting being that no backward step should be taken." At that session this committee announced "that it had taken under careful consideration the various possible measures embodied in the annual report of the Executive Committee and others, and that it had reached a conclusion in agreement with the sense of the Society as expressed at the first session that no backward step should be taken. The committee would accordingly suggest the amendment of the by-laws to the effect of increasing the annual dues for Members from $10 to $15, for Junior Members from $5 to $7.50, and the cost of membership in perpetuity from $200 to $300, with the understanding that if these proposed amendments should be approved at this meeting and on subsequent letter ballot, they shall not become effective till January 1, 1916.

"On motion, the Executive Committee was authorized to submit proposed amendments to the above effect to action by letter ballot of the Society."

The results of the letter ballot of Article VII, Sections 1 and 3, affecting finances, were as follows:

	AYE.	NAY.	NOT VOTING.	TOTAL
Article VII, Section 1	222	27	73	322
Article VII, Section 3	228	23	71	322

As a result of this ballot the increased dues became effective on January 1, 1916, the beginning of the current fiscal year.

From present indications it is to be anticipated that, barring expenditures in unexpected directions, the deficit of $6,407.03 at the beginning of the fiscal year will not only be extinguished, but that it will be converted into a moderate surplus by the end of the year, and that the financial affairs of the Society will thereafter be on a thoroughly sound business basis for the first time in the history of the organization. The cash balance in the treasury on June 1, 1916, was $15,666.86, with no unpaid bills, as compared with a cash balance of $6,480.79 at the corresponding period last year. The difference of $9,186.07 is seen to be considerably higher than the deficit of $6,407.03 at the beginning of the current fiscal year, or the estimated deficit of $7,500 at the end of the fiscal year if the dues had not been increased this year. Moreover, there is no ground for assuming that the prospective expenditures from June 1 to December 31, 1916, will greatly exceed those for the corresponding period last year.

In connection with the foregoing it should be recognized that the present cash balance and the receipts for the remainder of the year will have to be applied to the publication costs for the entire year, besides the regular operating and other expenses for the next six months.

As stated elsewhere in this report, notwithstanding the increase of fifty per cent in dues, the membership of the Society has shown a larger growth during the past year than for any corresponding earlier period. Moreover, the number of members whose dues for the current fiscal year remain unpaid is proportionally about the same this year as at corresponding periods in previous years. The Society may well congratulate itself on this indication of the esteem in which it is held by its own members and in outer circles.

As further substantial evidence in that direction attention may be called to the fact that the returns from the sales of publications for the fiscal year ending December 31, 1915, amount to $5,620.44 as against $4,587.13, which represents the previous high-water mark reached in 1914.

The annual receipts from the sale of rights to reprint certain Standards of the Society are now as follows:

Association of American Portland Cement Manufacturers	$250.00
Carnegie Steel Company	250.00
Hydrated Lime Bureau of the National Lime Association	100.00
Illinois Steel Company	100.00
National Tube Company	100.00
Southern Pine Association	250.00
Total	$1 050.00

By action of Committee D-1 on Preservative Coatings for Structural Materials, the balance of $70.53 from its Havre de Grace Bridge fund was paid into the treasury of the Society for the purpose of assisting in the defrayment of the cost of printing that part of the report of Committee D-1 relating to the Havre de Grace Bridge paint tests.

Inventory and Cost of Publications in Stock.—In the foregoing financial analysis no account has been taken of the assets of the Society in the form of publications in stock, the inventory of these on June 1, 1916, being as follows:

VOLUME.	COPIES.	VOLUME.	COPIES.	VOLUME.	COPIES.
I	37	VII	422	XIII	491
II	142	VIII	424	XIV, Part I	591
III	36	IX	544	XIV, Part II	592
IV	164	X	478	XV, Part I	480
V	269	XI	426	XV, Part II	417
VI	683	XII	173		

Total stock of Proceedings, 6369 volumes.

The stock of publications in general may be summarized as follows, the prices approximating their original cost:

Proceedings	6369	copies at $1.50	$9 553.50
Index (Vols. I–XII incl.)	772	" " .50	386.00
Reports of Committee D-1 (1903–1914 incl.)	387	" " 1.75	677.25
Total cost of publications in stock			$10 616.75

Proposed Biennial Publication of Standards.—The Executive Committee has given careful consideration during the past year to the criticism from various quarters that the Standards of the Society are subject to too frequent changes, and that this is not only undesirable from the standpoint of the users of these Standards in this country, but doubly so under the arrangement, referred to elsewhere in this report, by which the U. S. Department of Commerce has undertaken the translation of the leading Standards into foreign languages, and their distribution through the United States Consular offices throughout the world. The Executive Committee has also referred the consideration of this question to Committee E-5 on Standing Committees, and with the approval of that committee, it is recommended that the present contents of the Year-Book be published hereafter biennially in the even years in a special volume under the general title:

A. S. T. M. STANDARDS
Issued Biennially
by the
AMERICAN SOCIETY FOR TESTING MATERIALS
(Year of Issue)

Under this plan proposed new or proposed amended existing Standards, if introduced in the even years, would be published for two years in a section devoted to Tentative Standards in the Proceedings, and such matter introduced in the odd years would be so published for one year.

The adoption of this proposal involves certain changes in Article VI of the by-laws noted in detail below:

Proposed Amendment of the By-Laws.—The Executive Committee recommends the following changes in the by-laws:

ARTICLE I.

SEC. 3, second paragraph.—After the phrase: "A Junior Member shall have the same rights and privileges as a Member," insert "except that he shall not be eligible for office."

SEC. 4.—After the first sentence insert the following new sentence: "An Honorary Member shall have the same rights and privileges as a Member, except that he shall not be eligible for office."

ARTICLE III.

SEC. 6.—Add the following closing sentence: "The voter shall have the right to substitute any name or names of members of the Society for a corresponding number of names on the ballot."

ARTICLE VI.

SEC. 1.—For the second and third paragraphs, which read:

"Proposed new standards or proposed amendments of existing standards shall be presented at the Annual Meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Year-Book under a section designated 'Tentative Standards,' on which written discussions addressed to the appropriate committee shall be invited. At the next Annual Meeting these proposed new standards or proposed amendments of existing standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

"The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one year may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the Annual Meeting at which they are first presented. In that case the above provisions as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.",

substitute the following:

"Proposed new standards or proposed amendments of existing standards shall be presented at the Annual Meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Proceedings under a section designated 'Tentative Standards,' on which written discussions addressed to the appropriate committee shall be invited. If introduced in an even year such tentative standards shall be published for two years, and if introduced in an odd year they shall be published for one year. At the Annual Meeting in the next even year following their introduction, such tentative standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

"The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one or two years may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the Annual Meeting at which they are first presented. In that case the above prescribed vote as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected."

Add the following new Section 2:

"SEC. 2.—Reports, resolutions and recommendations pertaining to or involving the use, or proposed use, in a standard or tentative standard, of any device or process which forms the subject matter of any existing patent, shall first be submitted to the Executive Committee, and shall be submitted to the Society only with the approval of the Executive Committee."

Nomination of Officers.—The experience during the past year with the new by-laws governing the appointment of members of the nominating committee for officers was substantially the same as in the previous year when these by-laws first became effective. The total number of legal ballots was 193 as against 155 in the preceding year and the highest number of votes cast for any one candidate was 12 as compared with 10.

As pointed out in Circular No. 106, four of the six members of the nominating committee this year had served in a like capacity last year. The Executive Committee, after taking account of the circumstance that these four members had received the highest number of votes, was unwilling to assume the responsibility of discriminating against these members on the score of previous service. The Executive Committee wishes, however, to obtain an expression of the sense of this meeting as to the desirability of defining the future policy with reference to the successive appointment of the same individual on the nominating committee.

Changes in the Designation of Committees and Standards.—As previously announced in Circular No. 105, the Executive Committee, on the recommendation of Committee E-5 on Standing Committees, has authorized numerous changes in the designation of committees and standards, with a view of conciseness and consistency. The proposed changes were indicated in Circular No. 103 in order to give the members an opportunity to offer suggestions and criticisms. These proposed changes were subsequently confirmed by the Executive Committee and appear in detail in the appendix to this report. One general feature of these changes is that technical committees are now called standing committees.

Translation of Certain Standards into Foreign Languages by the U. S. Department of Commerce.—One of the most important and significant happenings during the past year is the arrangement made by the Executive Committee with the U. S. Department of Commerce by which such of the Standards of the Society as have an important bearing on the requirements of export trade will be translated into foreign languages by the Department of Commerce without expense to the Society, with a view of distributing these Standards among United States Consular offices and making them available at moderate prices to American manufacturers and others interested in foreign trade, under the following provisional agreement:

PROVISIONS INFORMALLY AGREED TO BETWEEN THE U. S. DEPARTMENT OF COMMERCE AND THE AMERICAN SOCIETY FOR TESTING MATERIALS.

1. That each Standard included in the translation will be published in the following form, and separately in each foreign language:

(*a*) An introductory statement in the foreign language covering briefly the history of the Society and the regulations governing the preparation and adoption of Standards;

(*b*) A like statement in the English language;

(*c*) The Standard in the foreign language and in the English language;

(*d*) A complete list of the Standards issued by the Department of Commerce; references to the languages in which each Standard is available; and the conditions governing their distribution and sale.

2. That the distribution of the Standards through consular offices will be made free of cost.

3. That the Standards will be made available to American corporations, firms, and individuals interested in export trade through purchase at moderate charges, but not lower than the

present scale of prices governing the sale of the Standards in English by the Society, these prices being as follows:

Single copies	25 cents	
For lots of 10 to 25	20 "	each
" " " 25 " 100	15 "	"
" " " 100 " 500	10 "	"
" " " 500 " 1000	7½ "	"
" " " 1000 and over	5 "	"

4. That the numeric values in the translated Standards will be given in the present British and in metric units.

In pursuance of extended correspondence and conferences with representatives of the standing committees chiefly affected, the Executive Committee decided to recommend to the U. S. Department of Commerce the translation of the following Standards into Spanish and French, coupled with the recommendation that the Standards comprised in Group I be first translated and then those comprised in Group II.

GROUP I (TOTAL 31).

A 1–14
A 2–12
A 3–14
A 4–14
A 5–14
A 7–15
A 9–14
A 10–14
A 14–14
A 17–13
A 18–14
A 19–14
A 20–14
A 21–14
A 23–12
A 24–12
A 26–14
A 27–14
A 28–13
A 52–15
A 53–15
A 30–14
A 31–14
A 38–12
A 39–14
A 40–13
A 41–13
A 42–13
A 44–04
A 45–14
C 1–09

GROUP II (TOTAL 31).

A 6–14
A 49–15
A 50–15
A 51–15
A 8–14
A 11–14
A 12–14
A 13–14
A 15–14
A 16–14
A 22–14
A 25–13
A 29–15
A 32–14
A 54–15
A 56–15
A 43–09
A 46–05
A 47–15
A 48–05
B 1–15
B 2–15
B 3–15
B 4–13
B 5–13
B 6–14
B 7–14
D 1–15
D 11–15
D 13–15
D 16–15

The question of translating certain ones or all of the above Standards into other languages, such as Portuguese and Russian, has been left open for the present.

According to recent advices from the Bureau of Standards the 31 Standards in Group I and 12 of the Standards in Group II will have been translated into Spanish by the end of June and will become ready for the printer as soon as any changes in these Standards that may be authorized by action initiated at this annual meeting can be made. The translations thus far have been limited to the Spanish language, since the funds available up to July 1 apply only to the development of South American trade, this undertaking being regarded as properly falling under that head.

Committee on the Proposed Joseph A. Holmes Memorial.— The Executive Committee has accepted an invitation to be represented on a committee that has been created for the purpose of establishing a suitable memorial to the late Dr. Joseph A. Holmes, who died on June 13, 1915, and who had held membership in this Society since 1903. Past-President A. W. Gibbs has been appointed as the representative of the Society on this committee.

Respectfully submitted on behalf of the Executive Committee,

MANSFIELD MERRIMAN,
President.

EDGAR MARBURG,
Secretary-Treasurer.

Office of the Secretary-Treasurer
University of Pennsylvania
Philadelphia, Pa.

EDITORIAL NOTE

The proposed amendments of the by-laws referred to in this report were adopted by letter ballot of the Society on September 1, 1916. The by-laws in their amended form appear on pages 7–14 of the 1916 Membership Pamphlet.

APPENDIX.

ABSTRACT OF MINUTES OF THE EXECUTIVE COMMITTEE.

Regular Meeting, June 23, 1915.—Hotel Traymore, Atlantic, N. J. Present: Mr. Mansfield Merriman, President; Mr. A. W. Gibbs and Mr. A. N. Talbot, Past-Presidents; Mr. A. A. Stevenson and Genl. W. H. Bixby, Vice-Presidents; Mr. J. H. Gibboney, Mr. W. K. Hatt, Mr. Robert Job, Mr. F. W. Kelley, Mr. J. A. Mathews, Mr. Edward Orton, Jr., and Mr. S. S. Voorhees, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 107 applications for membership; that the Society had suffered the loss by death of two members, and that one member had resigned, making the total membership in the Society on June 15, 1915, 1842.

In pursuance of an invitation to the Society to be represented at the Second Pan-American Scientific Congress, Washington, D. C., December 27, 1915–January 8, 1916, the President appointed Genl. W. H. Bixby as delegate and Past-President A. W. Gibbs as alternate.

The Secretary-Treasurer presented a communication under date of June 8, 1915, from Mr. W. P. Cutter, Secretary Joint Committee on Classification of Technical Literature, inviting the Society to appoint a representative on that Joint Committee. The Secretary-Treasurer further outlined the purposes of this joint committee and the impressions which he gained at its first meeting.

On motion it was decided to accept this invitation, with the understanding that this action would not commit the Society to any financial obligations, and the President accordingly appointed the Secretary-Treasurer.

A communication under date of June 1 from Mr. F. E. Schmitt tendering his resignation as the representative of the Society on the Joint Committee on Standards for Graphic Presentation, was presented and on motion accepted, with the understanding that the Society would thereby terminate its connection with that committee.

The following recommendations from Committee A-5 on Corrosion of Iron and Steel and Committee D-1 on Preservative Coatings for Structural Materials, were submitted, which had been offered in reply to an invitation to these committees to recommend to the Executive Committee, "whether the subject of metallic coatings for metals should (1) become part of the work of the respective committees; (2) become the work of a joint sub-committee of Committees D-1 and A-5; (3) become the work of an independent committee of the Society; and (4) be postponed as not feasible at the present time."

From Committee A-5 (through a verbal statement from its chairman, Mr. S. S. Voorhees), that it is the sense of Committee A-5 that this subject falls within the province of that committee but that they do not consider it expedient to take it up at this time, but that they will do so at the first opportunity.

From Committee D-1, through a letter under date of April 19, 1915: "that it is the sense of the meeting (Committee D-1) that metallic coatings are foreign to the work of the committee and that this subject had better be taken up by another committee."

On motion the Secretary-Treasurer was instructed to communicate with Committee A-5 suggesting that they consider the appointment of a sub-committee to take this matter up without delay.

On motion it was decided to take steps towards the amendment of the by-laws by action at the 1916 annual meeting of the Society by adding to Section 6, Article III on Nomination of Officers, the following sentence:

> "The voter shall have the right to substitute any name or names of members of the Society for a corresponding number of names on the ballot."

On motion, Committee E-6 on Papers and Publications was authorized to prepare a proposed plan designed to stimulate the sale of the back Proceedings of the Society.

The increasing financial needs of the Society, as set forth in the annual report of the Executive Committee, were then considered, and after prolonged discussion it was unanimously agreed to suggest the amendment of the by-laws by which, after January 1, 1916, the dues of Members would be raised from $10 to $15; those of Junior Members from $5 to $7.50; and the cost of membership in perpetuity from $200 to $300, with the understanding that all previously announced proposed changes in the by-laws bearing on finances be withdrawn.

The Secretary-Treasurer was, on motion, authorized to communicate with the various technical committees with a view of recommending on behalf of the Executive Committee the appointment of special sub-committees on increase of membership in the Society.

SPECIAL MEETING, June 24, 1915,—Hotel Traymore, Atlantic City, N. J. Present: Mr. Mansfield Merriman, President; Mr. A. N. Talbot and Mr. A. W. Gibbs, Past-Presidents; Genl. W. H. Bixby and Mr. A. A. Stevenson, Vice-Presidents; Mr. J. H. Gibboney, Mr. W. K. Hatt, Mr. F. W. Kelley and Mr. S. S. Voorhees, Members of Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The President announced the following appointments on the Finance Committee: Mr. A. A. Stevenson, Chairman, Genl. W. H. Bixby and Mr. J. H. Gibboney.

The following communication was presented from Committee C-1 on Cement, covering action taken by that committee at a meeting held on the previous evening, June 23:

> "Moved that the report of the Joint Conference be received and referred to suitable sub-committees of Committee C-1, to investigate and report. Said sub-committees to be appointed in accordance with the following rule of the committee:
>
> " 'Art. II, Sec. 2.—Sub-committees proposed by the committee shall be appointed by the Advisory Committee subject to final ratification by the committee.'

"Moved that the Executive Committee of the American Society for Testing Materials be asked to confer with the Board of Direction of the American Society of Civil Engineers and suggest that they withhold from general publication the Joint Conference report until this committee has had a sufficient opportunity (not longer than one year) to consider the report."

On motion of the Secretary-Treasurer it was decided to address a communication to the Board of Direction of the American Society of Civil Engineers, covering the following points:

1. That the Joint Conference had been created at the initiative of Committee C-1.
2. That the Joint Conference had made a report containing recommendations that the Standard Specifications for Cement of the Society be changed in many respects;
3. That Committee C-1 had appointed sub-committees to whom the Joint Conference report has been referred for consideration;
4. That it is the fixed policy of the Society not to give publicity to matters of this kind until they have been considered by the committees concerned;
5. That in view of the foregoing the American Society of Civil Engineers be requested to withhold the publication of the report of the Joint Conference for one year;
6. That if desired the Executive Committee will gladly confer with the Board of Direction of the American Society of Civil Engineers.

On motion of Mr. Stevenson the President was authorized to appoint a committee of three to draw up the proposed communication to be submitted to the Executive Committee for comment and criticism on the following day.

The President accordingly appointed Mr. A. N. Talbot, Mr. W. K. Hatt and Mr. Edgar Marburg.

REGULAR MEETING, October 23, 1915.—Engineers' Club, Philadelphia. Present: Mr. Mansfield Merriman, President; Mr. A. W. Gibbs and Mr. A. N. Talbot, Past-Presidents; Mr. A. A. Stevenson and Genl. W. H. Bixby, Vice-Presidents; Mr. J. H. Gibboney, Mr. W. K. Hatt, Mr. F. W. Kelley, Mr. A. Marston and Mr. S. S. Voorhees, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 111 applications for membership; that the Society had suffered the loss by death of four members; that three members had resigned; and that one member had been dropped for non-payment of dues, making the total membership in the Society on October 1, 1915, 1945.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended June 30, 1915, and attesting to their correctness.

The following report of Mr. H. H. Quimby and Mr. W. P. Taylor, tellers, was presented relative to the results of the letter ballot following the annual meeting:

	Aye	Nay	Not Voting
Proposed Amendment of the By-Laws:			
Article III, Section 2	210	5	107
Article III, Section 6	218	7	97
Article VI, Section 1	218	7	97
Article VII, Section 1	222	27	73
Article VII, Section 3	228	23	71
PROPOSED REVISION OF STANDARDS.			
Standard Specifications for:			
1. Structural Steel for Bridges	124	2	196
2. Malleable Iron Castings	110	3	209
3. Hard-Drawn Copper Wire	74	2	246
4. Medium Hard-Drawn Copper Wire	74	2	246
5. Soft or Annealed Copper Wire	74	2	246
6. The Purity of Raw Linseed Oil from North American Seed	83	0	239
Standard Methods for:			
7. Testing	186	2	134
Standard Definitions of:			
8. Terms Relating to Structural Timber	76	0	246
Standard Specifications for:			
9. Automobile Carbon and Alloy Steels (*as amended*)	115	0	207
10. Yellow-Pine Bridge and Trestle Timbers (*as amended*)	66	1	255
PROPOSED NEW STANDARDS.			
Standard Specifications for:			
1. Lap-Welded and Seamless Boiler Tubes for Stationary Service	111	2	209
2. Welded Steel and Wrought-Iron Pipe	110	3	209
3. Iron and Steel Chain	118	1	203
4. Cold-Drawn Steel: Open-hearth Automatic Screw Stock	114	2	206
5. Paving Brick	78	3	241
6. Quicklime	86	1	235
7. Hydrated Lime	87	1	234
8. The Purity of Boiled Linseed Oil from North American Seed	88	0	234
9. The Purity of Raw Chinese Wood Oil	76	1	245
10. $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use	61	4	257

PROPOSED NEW STANDARDS.—*Continued.*	Aye	Nay	Not Voting
Standard Methods for:			
11. Chemical Analysis of Alloy Steels	143	2	177
12. Testing of Cotton Rubber-Lined Hose	69	3	250
Standard Definitions of:			
13. Terms Applicable to Materials Relating to Roads and Pavements	76	13	233
Standard Specifications for:			
14. Quenched High-Carbon-Steel Splice Bars (*as amended*)	109	2	211
15. Quenched Carbon-Steel Track Bolts (*as amended*)	110	2	210
16. Quenched Alloy-Steel Track Bolts (*as amended*)	108	2	212
17. Turpentine (*as amended*)	78	2	242
Standard Definitions of:			
18. Terms Relating to Sewer Pipe (*as amended*)	59	0	263
19. Terms Used in Paint Specifications (*as amended*)	94	4	224

Total number of legal votes cast.................................... 322

The Secretary-Treasurer reported the appointment of Messrs. W. A. Doble and C. B. Wing by the President as the representatives of the Society at the San Francisco International Engineering Congress, stating further that no report had been received from these delegates.

The Secretary-Treasurer recommended that steps be taken towards the amendment of the by-laws by adding the words italicized below to Sections 3 and 4 of Article I:

ARTICLE I.
MEMBERS AND THEIR ELECTION.

SEC. 3.—Second paragraph.

A Junior Member shall have the same rights and privileges as a Member, *except that he shall not be eligible for office.* His status shall, etc.

SEC. 4.—After first sentence add:

An Honorary Member shall have the same rights and privileges as a Member, except that he shall not be eligible for office.

On motion this recommendation was approved.

The following questions were on motion referred for consideration and advice to a special committee to be appointed by the President:

1. Shall the Tentative Standards be hereafter printed in the form of a separate pamphlet, or in the Proceedings, instead of the Year-Book?
2. Shall the Year-Book be issued hereafter biennially under a suitably changed title?

The President appointed on this committee Messrs. A. N. Talbot, A. W. Gibbs, A. A. Stevenson, W. H. Bixby, and Edgar Marburg, chairman.

The following action was taken relative to the privilege of reprinting the Standards of the Society:

(*a*) The informal action of the Secretary-Treasurer in quoting a charge of $100 per annum to the Hydrated Lime Bureau of the National Lime Manufacturers' Association, for reprinting the Standard Specifications for Lime, and a charge of $250 per annum to the Southern Pine Association for reprinting the Standards relating to Timber, was, on motion, approved.

(*b*) The request of Mr. H. V. Wille, on behalf of the Baldwin Locomotive Works, to be permitted to reprint in various languages, without charge, certain Standards of the Society, indicated in his letter of September 29 was, on motion, approved, with the understanding that the legend

Authorized Reprint
From the Copyrighted Standards of the
American Society for Testing Materials,
Philadelphia, Pa.

shall appear on each reprint, and that the plates or type shall be placed without charge at the disposal of the Society for future reprints on its own account' if desired.

(*c*) The further request of Mr. Wille, on behalf of the Baldwin Locomotive Works, to be permitted to reprint, without charge, the Tentative Standards for (1) Helical and Elliptical Springs for Railways, and (2) Quenched and Tempered Alloy-Steel Axles, Shafts and other Forgings for Locomotives and Cars, was approved, with the understanding that in addition to the legend

Authorized Reprint
From the Copyrighted Tentative Standards of the
American Society for Testing Materials,
Philadelphia, Pa.

the following explanatory statement is to be added:

> "The term Tentative Standard is applied by the American Society for Testing Materials to a proposed Standard which is printed for one year with a view of eliciting criticism. The present Tentative Standards are subject to change at the annual meeting of the American Society for Testing Materials in June, 1916.",

and with the further understanding that the action in this instance relative to reprinting Tentative Standards shall not be regarded as a precedent.

On motion, an expenditure on the part of Committee C-1 not exceeding $500 was authorized for the year ending July 1, 1916, with the understanding that no part of this sum is to be applied to the cost of clerical help nor to stenographic reports of the meetings.

A booklet of condensed information concerning the Society, together with a printed draft of a proposed letter of transmission, both designed for distribution among the membership at large in support of a movement for increasing the membership of the Society, were submitted and approved.

A communication from Mr. D. A. Abrams, recommending the consideration of a plan of issuing a publication monthly or bi-monthly, was presented, which was, on motion, referred for consideration and advice to the special committee previously appointed on the question of issuing the Year-Book hereafter biennially.

A plan looking to the simplification and better systemization in the designation of Standing Committees and certain Standards, recommended by Committee E-5 on Standing Committees, was presented in the following form:

STANDING COMMITTEES.

NOTE.—The matter in parentheses is to be omitted. The matter in italics is new.

A. FERROUS METALS.

A-1 On (Standard Specifications for) Steel.
A-2 On (Standard Specifications for) Wrought Iron.
A-3 On (Standard Specifications for) Cast Iron and Finished Castings.
A-4 On Heat Treatment of Iron and Steel.
A-5 On Corrosion of Iron and Steel.
A-6 On Magnetic (Testing) *Properties* of Iron and Steel.
A-7
A-8 On (Standard Specifications for) Cold-Drawn Steel.
A-9
A-10 On Hardness Tests.—To be merged with Committee E-1 on Methods of Testing.

B. NON-FERROUS METALS.

B-1 On (Standard Specifications for) Copper Wire.
B-2 On Non-Ferrous Metals and Alloys.

C. CEMENT, LIME, GYPSUM, AND CLAY PRODUCTS.

C-1 On (Standard Specifications for) Cement.
C-2 On Reinforced Concrete.
C-3 On (Standard Specifications for) Brick.
C-4 On (Standard Tests and Specifications for Clay and Cement) Sewer Pipe (s).
C-5 On Fireproofing (Materials).
C-6 On (Standard Tests and Specifications for) Drain Tile.
C-7 On (Standard Specifications for) Lime.
C-8 On (Refractory Materials) *Refractories.*
C-9 On (Standard Tests of) Concrete and Concrete Aggregates.
C-10 On (Standard Specifications for) Hollow Building Tile.
C-11 On (Standard Specifications for) Gypsum and Gypsum Products.

D. MISCELLANEOUS MATERIALS.

D-1 On Preservative Coatings for Structural Materials.
D-2 On (Standard Tests for) Lubricants.
D-3 On Methods of Sampling and Analysis of Coal.
D-4 On (Standard Tests for) Road Materials.
D-5 On (Standard Specifications for) Coal.
D-6 On (Standard Specifications for) Coke.

D-7 On (Standard Specifications for) Timber.
D-8 On Waterproofing (Materials).
D-9 On (Standard Tests of Insulating Materials) *Electrical Insulation.*
D-10 On (Standard Tests and Specifications for) Shipping Containers.
D-11 On (Standard Specifications for) Rubber Products.
D-12
D-13 On (Standard Tests and Specifications for) Textile Materials.

E. MISCELLANEOUS SUBJECTS.

E-1 On (Standard) Methods of Testing.
E-2 On Electrical Standards.
E-3 On Revision of Pipe Threads.
E-4
E-5 On (Technical) *Standing* Committees.
E-6 On Papers and Publications.

STANDARDS.

NOTE.—The matter in parentheses is to be omitted. The matter in italics is new.

A 52-15. For Lap-Welded and Seamless *Steel and Wrought-Iron* Boiler Tubes for Stationary Service.
A 32-14. For Cold-Drawn (Steel: Bessemer) *Bessemer Steel* Automatic Screw Stock.
A 54-15. For Cold-Drawn (Steel: Open-Hearth) *Open-Hearth Steel* Automatic Screw Stock.
A 34-14. *For* Magnetic (Tests) *Properties* of Iron and Steel.
A 45–14. For *Cast-Iron* Locomotive Cylinders.
D 16-16. Of Terms (Used in Paint Specifications) *Relating to Preservative Coatings.*
D 8-15. Of Terms (Applicable) *Relating* to Materials (Relating to) *for* Roads and Pavements.

The Secretary-Treasurer was instructed to call attention to these proposed changes in the next Circular to Members with a view of inviting criticism from the Standing Committees affected.

The following recommendation to the Executive Committee was presented on behalf of Committee E-5 on Standing Committees and approved:

The addition of the following Section 2 to Article VI on Procedure Governing the Adoption of Standards, of the by-laws (see 1915 Membership Pamphlet, pp. 11-12),

> "SEC. 2.—Reports, resolutions and recommendations pertaining to or involving the use, or proposed use, in a Standard or Tentative Standard, of any device or process which forms the subject matter of any existing patent, shall first be submitted to the Executive Committee, and shall be submitted to the Society only with the approval of the Executive Committee."

REGULAR MEETING, January 18, 1916.—Rooms of the American Society of Mechanical Engineers, New York City. Present: Mr. Mansfield Merriman, President; Capt. R. W. Hunt and Mr. A. N. Talbot, Past-Presidents; Mr. A. A. Stevenson, Vice-President; Mr. J. H. Gibboney, Mr. W. K. Hatt, Mr. A. Marston, Mr. J. A. Mathews, and Mr. S. S. Voorhees, Members of Executive Committee; Mr. Edgar Marburg, Secretary-Treasurer;

The Secretary-Treasurer reported that favorable action had been taken on 50 applications for membership; that 30 members had resigned; that two members had been dropped; and that the Society had suffered the loss through death of six members, making the total membership in the Society on December 31, 1915, 1957.

The Secretary-Treasurer, on behalf of a special committee that had been appointed by the President to confer with the Department of Commerce relative to a plan looking to the translation and promulgation of selected Standards of the Society into foreign languages by the Department of Commerce, presented a report on the part of that committee, consisting of Vice-President Stevenson, Mr. W. R. Webster and Mr. Edgar Marburg, of which the following is a summary (complete report on file).

Provisions informally agreed to between representatives of the Society and of the Department of Commerce:

1. That each Standard included in the translation shall be published in the following form, and separately in each foreign language:

(*a*) An introductory statement in the foreign language covering briefly the history of the Society and the regulations governing the preparation and adoption of Standards;
(*b*) A like statement in the English language;
(*c*) The Standard in the foreign language and in the English language;
(*d*) A complete list of the Standards issued by the Department of Commerce; reference to the languages in which each Standard is available; and the conditions governing their distribution and sale.

2. That the distribution of the Standards through consular offices will be made free of cost.

3. That the Standards will be made available to American corporations, firms, and individuals interested in export trade through purchase at moderate charges, but not lower than the present scale of prices governing the sale of the Standards in English by the Society, these prices being as follows:

Single copies	25 cents	
For lots of 10 to 25	20 "	each
" " " 25 " 100	15 "	"
" " " 100 " 500	10 "	"
" " " 500 " 1000	7½ "	"
" " " 1000 and over	5 "	"

4. That the numeric values in the translated Standards are to be given in the present British and in metric units.

In pursuance of inquiries in interested circles the committee recommends:

1. That the above-stated conditions be approved and recommended to the Department of Commerce.

2. That the translation of the following Standards into French and Spanish, in the sequence stated, be recommended to the Department of Commerce, coupled with the recommendation that the Standards included in Group I be first translated and then those comprised in Group II:

GROUP I (TOTAL 31).

A 1–14
A 2–12
A 3–14
A 4–14
A 5–14
A 7–15
A 9–14
A 10–14
A 14–14
A 17–13
A 18–14
A 19–14
A 20–14
A 21–14
A 23–12
A 24–12
A 26–14
A 27–14
A 28–13
A 52–15
A 53–15
A 30–14
A 31–14
A 38–12
A 39–14
A 40–13
A 41–13
A 42–13
A 44–04
A 45–14
C 1–09

GROUP II (TOTAL 31).

A 6–14
A 49–15
A 50–15
A 51–15
A 8–14
A 11–14
A 12–14
A 13–14
A 15–14
A 16–14
A 22–14
A 25–13
A 29–15
A 32–14
A 54–15
A 56–15
A 43–09
A 46–05
A 47–15
A 48–05
B 1–15
B 2–15
B 3–15
B 4–13
B 5–13
B 6–14
B 7–14
D 1–15
D 11–15
D 13–15
D 16–15

3. That the question of translating certain ones or all of the above Standards into Portuguese or Russian be left open pending further inquiry.

On motion it was decided to approve the recommendations of this committee with respect to matters of policy, and to continue the committee with power to make such modifications in details as may seem suitable after a conference with the representatives of the Department of Commerce.

This committee, in conjunction with the President, was further authorized to give publicity to the agreement, with the approval of the Department of Commerce. Due announcement of this agreement was made to the members of the Society in Circular No. 105.

The Secretary-Treasurer presented a report from Messrs. John Heins & Co., Public Accountants and Auditors, certifying to the examination of the books and accounts of the Society for the six months ended December 31, 1915, and attesting to their correctness.

The following is a statement of the closely approximated, though estimated, deficit, and its analysis for the past four years, quoted from the certified report, dated January 6, 1916, of the auditors:

CONDITIONS AT CLOSE OF FISCAL YEARS 1912–1915, INCLUSIVE.

Fiscal Year.	Cash Balance.	Unpaid Bills.			Accounts Receivable.*	Deficit.
		On Hand.	Not yet Received.	Total.		
1912	$1,216.47	....	$2,500.00	$2,500.00	$385.79	$897.74
1913	1,139.87	$4,621.37	771.64	5,393.01	662.19	3,590.95
1914	43.57	6,199.05	222.22	6,421.27	1,044.74	5,332.96
1915	103.54	7,933.54	58.83	7,992.37	1,481.80	6,407.03

* Back dues not included.

The Secretary-Treasurer called attention to the fact that the deficit, which had been increasing at the average rate of about $2200 per annum from 1912 to 1913 and 1913 to 1914, had increased at about half that rate, or $1100, during the past year owing principally to the increased sales of publications which amounted for 1915 to the sum of $5620.44 as against $4587.13 for 1914.

He also expressed the opinion that, barring contingencies, the indications were that the deficit at the close of the last fiscal year would be converted into a small surplus by the end of the current fiscal year, owing to the increase in dues which did not go into effect till January 1, 1916.

Mr. J. H. Gibboney reported on behalf of the Finance Committee that, in pursuance of the provisions in the Regulations Governing the Finance Committee by which that committee shall inspect the books and accounts, etc., in the office of the Secretary-Treasurer at least once in two years, General Bixy and he had made such a visit of inspection about three months ago and that they had found the books and accounts kept in accordance with modern business methods and that they had found no occasion to suggest changes.

The proposal from the present publishers for the Society, The John C. Winston Co., Philadelphia, to renew the existing contract for printing and binding at the same figures as for the past five years, except an increased charge of five cents an hour for alterations, notwithstanding the increased cost of material and labor, was, on motion, accepted.

The Secretary-Treasurer presented the report of the tellers, Mr. T. Y. Olsen and Mr. F. M. Register, on the recent letter ballot of the Society for recommendations on appointments on the Nominating Committee for Officers, from which it appeared that 189 ballots bore two names each and 4 one name each, the total vote of 382 being distributed among 160 members.

On motion it was decided (1) that the members of the Executive Committee be not considered and (2) that the appointments be otherwise made according to the votes received by the various individuals notwithstanding the fact that four of the six members in the list, namely, Messrs. Young, Capp, Humphrey and Thompson, had served on this committee last year.

Names in order of votes exclusive of Members of Executive Committee:

Members.	*Alternates.*
Young, C. D.	Rys, C. F. W.
Capp, J. A.	Goodell, J. M.
Humphrey, R. L.	Wagner, S. T.
McLeod, John.	Lober, J. B.
Wig, R. J.	Webster, G. S.
Thompson, G. W.	Aertsen, G.

The following report on recommended changes in the publications of the Society was presented by the Secretary-Treasurer on behalf of the following special committee: Genl. W. H. Bixby, Mr. A. W. Gibbs, Mr. A. A. Stevenson, Mr. A. N. Talbot and Mr. Edgar Marburg (Chairman):

1. That the contents of the Year-Book be hereafter published biennially during the even years beginning with 1916.
2. That this publication bear the following title:

BOOK OF STANDARDS
Issued Biennially
by the
AMERICAN SOCIETY FOR TESTING MATERIALS
1916

3. That proposed new Standards or proposed amended existing Standards be designated "Tentative Standards" as now and published yearly in a separate pamphlet, but not in the Year-Book or the Proceedings.

4. That letter ballots on proposed new Standards and proposed amended existing Standards be taken only in the years of publication of the Book of Standards, that is, in the even years.

5. That proposed new or proposed amended existing Standards be published for one or two years according to whether they are introduced and accepted for publication during odd or even years.

On motion it was decided to approve the recommendations in Sections 1, 2, 4 and 5, and to refer the questions involved in Section 3, as to the form in which Tentative Standards shall hereafter be published, to Committee E-5 on Standing Committees for consideration and advice.

As to the adoption of a plan for issuing a monthly or bi-monthly publication, which was also referred for consideration to the above special committee, the recommendation of the committee that action in this matter be held in abeyance for a year, pending improvement in the financial condition of the Society, and that in the meantime this matter be also referred to Committee E-5 for consideration and advice was, on motion, approved.

On motion it was decided to hold the next annual meeting of the Society at the Hotel Traymore, Atlantic City, N. J., on June 27–July 1.

In relation to the general question of cooperation with other national societies, which had been brought up at several previous meetings, it was decided that the conditions of such cooperation shall be independently determined as the occasion for such cooperation may arise.

The Secretary-Treasurer reported that the proposed changes in the designation of technical committees and Standards, agreed to at the last meeting of the Executive Committee, had been announced in Circular No. 103 to the members, with a view of giving an opportunity for criticism, especially on the part of the committees affected. Since no criticisms or suggestions had in the meantime been received it was voted to make these proposed changes effective.

A letter under date of November 1, 1915, from Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings, was presented, in which he announced the decision of that committee to place the balance of $70.53 from its Havre de Grace bridge fund in the treasury of the Society for the purpose of assisting in the defrayment of the cost of printing that part of the report of Committee D-1 relating to the Havre de Grace bridge tests.

On motion it was decided to accept this contribution and the Secretary-Treasurer was instructed to convey the thanks of the Executive Committee to Committee D-1.

The request, under date of November 2, 1915, from Mr. W. A. Noyes, Chairman of the Joint Committee on Methods of Sampling and Analysis of Coal, that this Society continue its cooperation with the American Chemical Society, through Committee D-3 on Methods of Sampling and Analysis of Coal, was, on motion, approved.

An invitation under date of January 15, 1916, from Mr. G. S. Rice, Temporary Secretary, that the Society be represented on a committee that had been created for the purpose of establishing a suitable memorial to the late Dr. Joseph A. Holmes, who had held membership in the Society from 1903 till his death on July 13, 1915, was, on motion, accepted. The President announced the appointment of Past-President A. W. Gibbs, as the representative of the Society on this committee.

The Secretary-Treasurer reported the receipt of a letter, under date of November 1, 1915, from Mr. W. A. Cattell, Secretary, International Engineering Congress, to President Merriman, to the effect that the Committee of Management of the International Engineering Congress had adopted a resolution "authorizing the Secretary to express to all the Governments, Bureaus and Societies who had appointed delagates to the Congress, of its deep appreciation of the courtesy thus tendered to this international gathering, and further to thank the delegates who were in attendance for the efforts and sacrifices which they made to be present," and thanking him personally for his attendance which had added materially to the success of the Congress, and through him the American Society for Testing Materials for his appointment.

On motion it was decided to continue the present policy of making suitable charges for the right to reprint the Standards of the Society for commercial purposes.

REGULAR MEETING, April 11, 1916.—Engineers' Club, Philadelphia. Present: Mr. Mansfield Merriman, President; Mr. A. W. Gibbs, Past-President; Mr. A. A. Stevenson and Genl. W. H. Bixby, Vice-Presidents; Mr. F. W. Kelley and Mr. S. S. Voorhees, Members of Executive Committee; and Mr. Edgar Marburg, Secretary-Treasurer.

The Secretary-Treasurer reported that favorable action had been taken on 119 new applications for membership; that 67 members had resigned; that 63 members had been dropped from membership for non-payment of 1915 dues; and that the Society has suffered the loss through death of four members, making the total membership on March 31, 1916, 1942.

The question of appointing a committee to prepare Standards for composition floor materials was, on motion, laid on the table.

On motion the recommendation contained in a letter from the Secretary of the Land Grant College Engineering Association, under date of October 26, 1915, soliciting the support of the Society in connection with a proposed bill for "Mechanic Arts Experimentation, a 'a preparedness-for-war' measure which seeks to increase the industrial efficiency of the United States" was laid on the table.

In pursuance of a letter dated February 8, 1916, from the Secretary of Committee A-1 on Steel, previously approved by the Chairman of the Finance Committee, an appropriation of $200 to meet the expenses of the committee during the current fiscal year was approved.

The Secretary-Treasurer's action authorizing the Illinois Steel Co. to reprint the Standard Specifications for Splice Bars, Track Bolts, Track Spikes, Screw Spikes and Tie Plates at an annual compensation of $100 to the Society was approved.

The Secretary-Treasurer quoted the following excerpt from the minutes of the meeting of Committee E-5 on Standing Committees held on February 26, relating to items which had been referred to that committee by the Executive Committee:

1. The recommendation that the title "Book of Standards" be changed to "A. S. T. M. Standards," the complete title being then as follows:

A. S. T. M. STANDARDS
Issued Biennially
by the
AMERICAN SOCIETY FOR TESTING MATERIALS
1916

2. The recommendation to discontinue further consideration of the question of issuing a monthly or bi-monthly journal as inexpedient and undesirable.

On motion the first recommendation was approved.

Relative to the second recommendation it was decided, in pursuance of action at the previous meeting, to defer final action till after the close of the current fiscal year.

On motion the Secretary-Treasurer was authorized to bring the necessary changes in the by-laws in connection with the proposed change in publication, by which the present Year-Book is to be superseded by the publication of a biennial A. S. T. M. Standards, to the notice of the membership at large.

Relative to the resolution adopted at the last annual meeting "that no specifications shall contain any discrimination between two or more materials unless such specifications contain a method of distinguishing these materials," it was decided that it was inexpedient to approve this proposal because in some cases there were no known methods of distinguishing different materials without direct knowledge of their origin.

A communication under date of April 10 from Mr. Rudolph Hering, Chairman of Committee C-4 on Sewer Pipe, was presented, recommending on behalf of that committee that the proposed Tentative Recommended Practice for the Laying of Sewer Pipe, published in the 1915 Year-Book be referred to letter ballot of the Society for adoption with certain minor alterations.

It was the sense of the meeting that it would be undesirable to approve this recommendation prior to the presentation by the committee of the proposed Standard Specifications for Sewer Pipe, which are to be based thereon, inasmuch as the relation between the latter and the Recommended Practice in question cannot be definitely judged in the meantime.

A communication under date of April 10, 1916, from Mr. R. J. Wig, Chairman of Committee C-11 on Gypsum and Gypsum Products, with an accompanying tentative draft of proposed Standard Specifications for Interior Plastering with Gypsum Plaster was presented. It was the sense of the meeting that inasmuch as this matter had been received too late for adequate analysis or for prior reference to authorities, the Secretary-Treasurer be authorized to inform the committee that they may feel free to present these proposed standard specifications at the approaching annual meeting of the Society, with the understanding that further steps will be governed by the discussion and action at the annual meeting.

The report was presented on the part of the Nominating Committee for Officers to the effect that at a meeting of that committee held on March 29, 1916, at which were present Past-Presidents A. N. Talbot and A. W. Gibbs, and Messrs. J. A. Capp, R. L. Humphrey, John McLeod, C. D. Young and R. J. Wig, the following nominations were unanimously agreed to:

For President: A. A. Stevenson.

For Vice-President: S. S. Voorhees.

For Members of Executive Committee: W. H. Bassett, John Brunner, G. W. Thompson, F. E. Turneaure.

The appointment of the Entertainment Committee for the approaching annual meeting was left with power to the President and the Secretary-Treasurer, and a sum not exceeding $100 was appropriated for the use of that committee.

On motion Committee E-6 on Papers and Publications was authorized to omit the Saturday forenoon session if feasible.

A report to the Executive Committee on the part of Mr. J. H. Smith and Mr. C. E. Chase, who acted as delegates of the Society to the Sixth American Good Roads Congress, held at Pittsburgh, February 28 to March 3, was presented and ordered filed.

SPECIAL MEETING, June 27, 1916.—Hotel Traymore, Atlantic City, N. J. Present: Mr. Mansfield Merriman, President; Genl. W. H. Bixby and Mr. A. A. Stevenson, Vice-Presidents; Mr. F. W. Kelley and Mr. S. S. Voorhees, Members of Executive Committee; Mr. A. W. Gibbs, Past-President; and Mr. Edgar Marburg, Secretary-Treasurer.

The President stated that the meeting had been called for the consideration of the form of the financial statement as it appeared in the preprint of the annual report of the Executive Committee.

On motion it was decided to print in connection with this year's report, a financial statement for the period from June 1, 1915, to June 1, 1916, in the same form as that published a year ago (see Proceedings, Vol. XV, Part I, pp. 59–60).

On motion the present Finance Committee was instructed to report to the Executive Committee at its October meeting its recommendations concerning the form and scope of the future annual financial statements, and to submit therewith in that connection a definite form.

REPORT OF COMMITTEE A-1

ON

STEEL.

Since the last annual meeting, Committee A-1, which now numbers 97 as compared with 96 last year, has held two well-attended meetings with an average attendance of 41 members present and 26 absent with written excuse.

Sub-Committees.—A new Sub-Committee on Tool Steel has been organized, with instructions to prepare specifications for carbon-tool steel. There are now sixteen sub-committees of Committee A-1, including the Advisory Committee.

Regulations.—The Advisory Committee has revised the Regulations Governing Committee A-1 by the addition of the following article, designed to secure as complete a vote by the members of the committee upon its recommendations and report as possible, it being felt that any member of a committee who does not show sufficient interest in the work of that committee to cast such a vote should be asked to show cause why he should retain his membership:

ARTICLE VII.

LETTER BALLOTS.

SECTION 1. As required by the Regulations Governing Standing Committees, the Secretary shall submit to letter ballot of the committee (1) any recommendations affecting standards which have been approved by majority vote of those voting at a meeting of the committee, and (2) the report of the committee to the Society. Each ballot shall be provided with three columns, entitled respectively "Affirmative," "Negative" and "Not Voting."

SEC. 2. The failure of any member of the committee to mark such ballot and return it to the Secretary shall be construed as showing a lack of interest on the part of the member in the work of the committee; in which case the Secretary, on the approval of the chairman of the committee, shall notify the member of his failure to comply with this regulation and shall ascertain whether he desires to continue as a member of the committee.

Recommendations.—The recommendations of the committee affecting standards and tentative standards, which will be referred to in greater detail later in the report, originated in the respective sub-committees and were carefully considered by the committee at its meetings before being referred to letter ballot of the committee. The committee has cooperated with committees from other associations in a number of instances and every effort has been made to harmonize conflicting requirements in various specifications. Further reference to this cooperation is made later.

The recommendations are briefly as follows:

I. PROPOSED REVISIONS IN STANDARDS.

The committee recommends that the following standard specifications be revised (*a*) in accordance with the detailed recommendations contained in Appendix I[1] to this report for specifications Nos. 1 to 14, inclusive, in the following list, and (*b*) as printed and appended to this report (specifications Nos. 15–17, inclusive),[2] and referred to letter ballot of the Society for adoption. The committee believes it desirable to have these revisions referred to letter ballot this year, rather than printed as tentative for one year, and accordingly asks for the necessary nine-tenths vote at this meeting.

(*a*) *Recommended Revisions Contained in Appendix I.*

1. For Structural Steel for Bridges (A 7–15);
2. For Structural Nickel Steel (A 8–14);
3. For Structural Steel for Buildings (A 9–14);
4. For Structural Steel for Locomotives (A 10–14);
5. For Structural Steel for Cars (A 11–14);
6. For Structural Steel for Ships (A 12–14);
7. For Carbon-Steel Bars for Railway Springs (A 14–14);
8. For Carbon-Steel and Alloy-Steel Forgings (A 18–14);
9. For Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 19–14);
10. For Carbon-Steel Forgings for Locomotives (A 20–14);

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[1] P. 111.

[2] The proposed revisions in these specifications are so extensive that it has been deemed advisable simply to call attention to them in a general way (pp. 99–103) and to append the specifications in their proposed revised form. NOTE.—These specifications are not reprinted here, but appear in the 1916 Volume of A.S.T.M. Standards.—ED.

11. For Cold-Rolled Steel Axles (A 22-14);
12. For Steel Castings (A 27–14);
13. For Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes (A 28–13);
14. For Boiler and Firebox Steel (A 30–14).

(*b*) *Specifications Appended in Revised Form.*

15. For Wrought Solid Carbon-Steel Wheels for Steam Railway Service (combination and revision of Standard Specifications A 23–12 and A 24–12);
16. For Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–13);
17. For Steel Tires (A 26–14).

II. PROPOSED STANDARD SPECIFICATIONS (AT PRESENT TENTATIVE).

The specifications listed under this heading have been published in the Year-Book for one year as tentative. With the exception of Nos. 21 and 22, proposed changes in the specifications indicated are given in Appendix I, and the specifications are not printed here. The Tentative Specifications for Helical and Elliptical Springs for Railways have been divided into two separate specifications (Nos. 21 and 22), and rearranged as to form without making any change in the substance of the original specifications. These two specifications are appended to this report.[1]

The committee recommends that these seven specifications, as amended where indicated, be referred to letter ballot of the Society for adoption as standard:

18. For Carbon-Steel Bars for Vehicle and Automobile Springs;
19. For Silico-Manganese-Steel Bars for Automobile and Railway Springs (as amended in Appendix I);
20. For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (as amended in Appendix I);
21. For Helical Springs for Railways;

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[1] These specifications are not reprinted here, but appear in the 1916 Volume of A.S.T.M. Standards.—ED.

TABLE SHOWING ANALYSIS OF VOTE OF COMMITTEE A-1 ON ITS RECOMMENDATIONS.

Items.	Affirmative.	Negative.	Not Voting.[1]
I. PROPOSED REVISIONS IN STANDARD SPECIFICATIONS.			
(a) Recommended Revisions Contained in Appendix I.			
1. For Structural Steel for Bridges (A 7–15)	67	3	27
2. For Structural Nickel Steel (A 8–14)	65	3	29
3. For Structural Steel for Buildings (A 9–14)	68	3	26
4. For Structural Steel for Locomotives (A 10–14)	66	2	29
5. For Structural Steel for Cars (A 11–14)	66	4	27
6. For Structural Steel for Ships (A 12–14)	58	2	37
7. For Carbon-Steel Bars for Railway Springs (A 14–14)	62	2	33
8. For Carbon-Steel and Alloy-Steel Forgings (A 18–14)	66	3	28
9. For Quenched-and-Tempered Carbon-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (A 19–14)	61	4	32
10. For Carbon-Steel Forgings for Locomotives (A 20–14)	60	1	36
11. For Cold-Rolled Steel Axles (A 22–14)	49	1	47
12. For Steel Castings (A 27–14)	59	2	36
13. For Lap-Welded and Seamless Steel Tubes, Safe Ends and Arch Tubes (A 28–13)	53	1	43
14. For Boiler and Firebox Steel (A 30–14)	56	7	34
(b) Specifications Appended in Revised Form.			
15. For Wrought Solid Carbon-Steel Wheels for Steam Railway Service (combination and revision of Standard Specifications A 23–12 and A 24–12)	49	0	48
16. For Wrought Solid Carbon-Steel Wheels for Electric Railway Service (A 25–13)	40	0	57
17. For Steel Tires (A 26–14)	48	0	49
II. PROPOSED STANDARD SPECIFICATIONS (AT PRESENT TENTATIVE).			
18. For Carbon-Steel Bars for Vehicle and Automobile Springs	51	0	46
19. For Silico-Manganese-Steel Bars for Automobile and Railway Springs (as amended in Appendix I)	57	2	38
20. For Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (as amended in Appendix I)	56	2	39
21. For Helical Springs for Railways	53	0	44
22. For Elliptical Springs for Railways	50	3	44
23. For Alloy-Steel Forgings (as amended in Appendix I—to be combined with Specification A 18–14)	56	3	38
24. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (as amended in Appendix I)	54	3	40

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[1] Of the 97 members of the committee, 11 failed to vote on any of the items listed. The numbers obtained by subtracting 11 from each number in the last column, represent the number of votes cast as "not voting" on the various items.

TABLE SHOWING ANALYSIS OF VOTE OF COMMITTEE A-1 ON ITS RECOMMENDATTIONS.—*Continued.*

Items.	Affirm-ative.	Nega-tive.	Not Voting.[1]
III. PROPOSED TENTATIVE SPECIFICATIONS.			
25. For Steel Track Spikes	48	1	48
26. For Steel Screw Spikes	49	1	47
27. For Steel Tie Plates	44	6	47
28. For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements	47	4	46
29. For Elliptical Springs for Automobiles	42	0	55
30. For Boiler and Firebox Steel for Stationary Service	51	5	41
IV. MISCELLANEOUS RECOMMENDATIONS.			
31. Revision of Standard Methods for Chemical Analysis	69	1	27
32. Revision of Requirements for 2-in. Tension Test Specimens	69	0	28
33. Revision of Form of Sections on Ladle and Check Analyses	67	1	29

Total number of ballots cast	86
Number of members who failed to vote	11
Total membership	97

22. For Elliptical Springs for Railways;
23. For Alloy-Steel Forgings (as amended in Appendix I—to be combined with Specification A 18–14);
24. For Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (as amended in Appendix I).

III. PROPOSED TENTATIVE SPECIFICATIONS.

The committee recommends that the following six proposed tentative specifications, appended to this report,[2] be published as tentative:

25. For Steel Track Spikes;
26. For Steel Screw Spikes;

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[1] Of the 97 members of the committee, 11 failed to vote on any of the items listed. The numbers obtained by subtracting 11 from each number in the last column, represent the number of votes cast as "not voting" on the various items.

[2] These specifications appear on pp. 410–433.—ED.

27. For Steel Tie Plates;
28. For Carbon-Steel Bars for Railway Springs with Special Silicon Requirements;
29. For Elliptical Springs for Automobiles;
30. For Boiler and Firebox Steel for Stationary Service.

IV. MISCELLANEOUS RECOMMENDATIONS.

The committee recommends:

31. That the Standard Methods for Chemical Analysis of Plain Carbon Steel (A 33–14) and of Alloy Steels (A 55–15) be revised by the addition of the explanatory sentence noted later in the report under the heading "Methods of Chemical Analysis."[1]

32. That the proposed revision of the requirements for 2-in. tension test specimens, as given later in the report under the heading "Methods of Physical Tests,"[2] be made in all specifications affected.

33. That the Sections on Ladle and Check Analyses in the various specifications be revised as to form as indicated later in the report under the heading "Literary Form."[3]

These three recommendations are considered by the committee to be matters of form rather than substance, so that if authorized at this meeting their insertion in the various specifications affected will not require a change in the date of adoption or last revision.

The results of the letter ballot of the committee on the above recommendations are given in the accompanying table.

The committee presents its recommendations in greater detail below. Owing to the diversity of the subjects in charge of the committee, it has been deemed best to group these recommendations in the order of the respective sub-committees directly responsible for them, so that all questions pertaining to the various specifications for a given class of material will be found together.

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[1] Pp. 105–106.
[2] Pp. 106–108.
[3] Pp. 108–109.

PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS OF SHEARED PLATES.

During the past year the committee has continued its consideration, in cooperation with The Association of American Steel Manufacturers, of the question of permissible variations in weight and thickness of sheared plates, using as a basis the tables drawn up by the manufacturers and appended to the 1914 report[1] of the committee for the information of the Society. After careful study by a special representative committee,[2] the tables contained in Appendix I[3] were prepared. They have been approved by the committee with substantial unanimity, and are recommended for adoption as standard. If thus adopted by the Society they will be formally submitted for adoption to the members of The Association of American Steel Manufacturers.

Adoption of these requirements by the Society will carry with it their insertion in the following standards, to replace the present requirements: A 7–15, A 8–14, A 9–14, A 10–14, A 11–14, A 12–14, and A 30–14 (as to requirements for plates ordered to thickness only).

STEEL RAILS AND ACCESSORIES (SUB-COMMITTEE I).

Proposed Tentative Specifications.—In pursuance of its purpose announced last year,[4] the committee has prepared and recommends for publication as tentative the following three specifications appended to this report:

1. Specifications for Steel Track Spikes;
2. Specifications for Steel Screw Spikes;
3. Specifications for Steel Tie Plates.

Rail Situation.—Due to the performance of rails in track on American railways, the last five years have been occupied by a closer study of causes productive of failures, with the hope that they may be reduced or eliminated. A large amount of research work has been done by the American Railway Engineering Association, as well as by some of the larger consuming and producing interests. Two ideas predominate: one is the elimination of the failures which are commonly associated with segregation, and the other the elimination of the failure by transverse fissure.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 100 (1914).

[2] *Ibid.*, Vol. XV, Part I, pp. 88–89 (1915).

[3] Pp. 111–113.

[4] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 89 (1915).

SEGREGATION.

There seems to be a fairly well crystallized opinion that split heads and mashed heads are generally associated with segregation, and a number of tests have been proposed which will permit the easy detection of this condition. Those most commonly known are:

1. *Estimation of Segregation by means of Chemical Analysis of Center and Outside of the Rail.*—The objection to this test is the cost involved and the equipment required. The facilities which have been found necessary by the large railroad which has used this method are probably beyond the reach of many smaller railroads. The results, however, are definite, are not to any great extent functions of the personal equation of an inspector, and the service in track of rails which were purchased subject to this method of testing are exceptionally good, the rails being practically free from failures after a considerable period of service.

2. *Estimation of Segregation by the Appearance of the Transversely Fractured Section of the Rail.*—The estimation of segregation from the appearance of the fracture is claimed to be much affected by the personal equation of the individual, and is not of such a positive character as to permit of any absolute check in case of disagreement between the manufacturer and the inspector. It is further claimed that the results obtained in some experiments, made to corroborate and correlate the results of judgment based on appearance of fracture with chemical analyses made on drillings taken from the fractured piece, showed that while in some cases the judgment based on the fracture was corroborated by analysis, in many cases it was contradicted.

3. *Estimation of Segregation by means of Brinell Hardness Tests made at Center and Outside of a Transverse Section of the Rail.*—Experiments have been made to determine whether segregation in rails can be detected by Brinell hardness tests

at center and outside of a transverse section, checking the hardness readings by chemical analyses. The results obtained were not of a character to give much hope that this method would be of practical value.

TRANSVERSE FISSURES.

This type of failure, which has come into prominence in the last few years, is not as clearly understood as the other principal types which have been under observation for a longer period. Various theories have been advanced as to the causes of this type of failure, varying from included foreign matter in combination with high chemical hardeners and internal stresses to possible checks from cooling or from cold straightening. Although the initial cause at the start of the fracture is unknown, it is generally agreed that the development of the fracture up to the point of final break-down of the section is due to repeated loading, causing deflection, upon the rail in track. On the other hand, some engineers attribute this type of failure to the action of heavy wheel loads and the stress produced in the rail by the cold rolling of the surface under traffic in combination with some unknown condition in the steel. No definite proof has been offered as to the absolute cause for this type of failure and, therefore, the means of correction are not at hand.

In general, the research which is being done upon rail steel is being carried forward in such a manner as to justify hope for the future. Both manufacturers and consumers are active in endeavoring to improve the quality of the steel in order to eliminate the failures, and are working out the problem in thorough cooperation.

STRUCTURAL STEEL (SUB-COMMITTEE II).

Proposed Revision in Standard Specifications for Structural Steel for Cars.—On invitation of the Committee on Specifications of the Master Car Builders' Association, Committee A-1, through its Sub-Committee II, conferred with representatives of the M. C. B. committee with a view of harmonizing conflicting requirements in the specifications of that Association and of the Society relating to rivet steel for cars. To that end, the Master Car Builders' Committee will recommend that their specifications be amended as to chemical requirements and number of tests to agree with ours, while Committee A-1 recommends that in our specifications (Structural Steel for Cars: A 11–14) the requirements as to tensile strength of rivet steel be changed from 48,000–58,000 to 45,000–60,000 lb. per sq. in.

Detailed reference to this and other recommended changes in these specifications is contained in Appendix I.

SPRING STEEL AND STEEL SPRINGS (SUB-COMMITTEE IV).

Specifications for Spring Steel.—Four specifications for bars for steel springs were printed in the 1915 Year-Book as follows:

1. Standard Specifications for Carbon-Steel Bars for Railway Springs (A 14–14);
2. Tentative Specifications for Carbon-Steel Bars for Vehicle and Automobile Springs;
3. Tentative Specifications for Silico-Manganese-Steel Bars for Automobile and Railway Springs;
4. Tentative Specifications for Chrome-Vanadium-Steel Bars for Automobile and Railway Springs.

It was stated in the report of the committee last year[1] that requirements as to permissible variations in the dimensions of bars for vehicle and automobile springs were left subject to agreement between the manufacturer and the purchaser, pending further consideration of this question by the committee. The committee now recommends that requirements as to permissible variations in dimensions for all bars—including bars for railway springs—be subject to agreement between the manufacturer and the purchaser, and that the specifications as thus amended (specification No. 2 above requires no amendment) be referred to letter ballot for adoption as standard.

The committee announces that it will make certain necessary changes in the form of these specifications to harmonize them in this respect.

The committee also recommends that the proposed Tentative Specifications for Carbon-Steel Bars with Special Silicon Requirements, appended to this report, be published among the Tentative Standards of the Society.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, pp. 83–84 (1915).

Specifications for Steel Springs.—Last year the committee presented Tentative Specifications for Helical and Elliptical Springs for Railways, which were published in the 1915 Year-Book. The committee considers it advisable to divide these specifications into two separate specifications, one for helical and one for elliptical springs. This has been done, at the same time improving the form without changing the substance, and the committee now recommends for adoption as standard the Specifications for Helical Springs for Railways and the Specifications for Elliptical Springs for Railways appended to this report.

In pursuance of its purpose announced last year,[1] the committee has prepared and recommends for publication as tentative the proposed Tentative Specifications for Elliptical Springs for Automobiles. These specifications are based upon those under consideration by the Society of Automobile Engineers, with whom the committee is cooperating, and are virtually the same as the S. A. E. specifications as far as the material requirements are concerned, except that the form has been changed to accord with the regulations of this Society.

STEEL FORGINGS (SUB-COMMITTEE VI).

The following list of standard and tentative specifications for forgings and cold-rolled axles considered in this report is given first for convenient reference:

Standard Specifications.

1. For Carbon-Steel and Alloy-Steel Forgings (A 18–14);
2. For Quenched-and-Tempered Carbon-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars (A 19–14);
3. For Carbon-Steel Forgings for Locomotives (A 20–14);
4. For Cold-Rolled Steel Axles (A 22–14).

Tentative Specifications.

5. For Alloy-Steel Forgings;
6. For Quenched-and-Tempered Alloy-Steel Axles, Shafts, and Other Forgings for Locomotives and Cars.

The recommendations of the committee with respect to these specifications are given in detail in Appendix I, where the proposed revisions are listed under the respective specifications. It is desirable, however, to refer to these revisions in a more general way.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 89 (1915).

Determination of Elastic Limit.—Elastic limit is called for in specifications Nos. 1, 2, 4, 5 and 6 of the above list. At present it is stated that "the elastic limit shall be determined by means of an extensometer." The method of determining elastic limit for the purposes of these specifications was considered by Sub-Committee XIII on Methods of Physical Tests. This sub-committee submitted the following, which was adopted by the committee:

> "The elastic limit called for by these specifications shall be determined by an extensometer reading to 0.0002 in. The extensometer shall be attached to the specimen at the gage marks and not to the shoulders of the specimen nor to any part of the testing machine. When the specimen is in place and the extensometer attached, the testing machine shall be operated so as to increase the load on the specimen at a uniform rate. The observer shall watch the elongation of the specimen as shown by the extensometer and shall note, for this determination, the load at which the rate of elongation shows a sudden increase. The extensometer shall then be removed from the specimen, and the test continued to determine the tensile strength."

In recommending that this method be inserted in specifications Nos. 1, 2, 4, 5 and 6, to replace the existing requirement, the committee desires to emphasize its intention that the method shall be applicable only to the specifications named—that is, to heat-treated or cold-rolled steels—and not, for example, to non-ferrous metals.

Definition of Crystallin Fracture.—Specifications Nos. 2, 3 and 6 of the above list contain requirements involving the determination of the crystallin nature of the fracture of a tension test specimen. The committee recommends that the following sentence, defining crystallin for the purpose of these specifications, be added:

> "The fracture shall be considered crystallin if the crystals which it contains are so large that the cleavage planes or sides of these crystals are easily visible to the eye."

Rough Turning of Collars.—The committee announced in its report last year[1] its intention of recommending, when other changes were under consideration, that specification No. 2 of the above list be made to agree with No. 6 in requiring that the collars of axles or other forgings be rough-turned, instead of being left rough-forged. This revision, as given in Appendix I for Sections 5 (*a*) and 16 for specification No. 2 (A 19–14), is recommended this year for adoption.

Tentative Specifications Recommended for Adoption as Standard.—During the past year the Specifications for Alloy-Steel Forgings and for Quenched-and-Tempered Alloy-Steel Axles, Shafts and Other Forgings for Locomotives and Cars (Nos. 5 and 6 of the above list) have been published in the Year-Book as tentative. In each of these specifications, the chemical composition of the steel other than requirements as to phosphorus and sulfur is subject to agreement between the manufacturer and the purchaser. In a footnote to the specifications are given chemical compositions as nearly typical as any now regularly manufactured. The committee is not yet prepared, however, to include these compositions as requirements of the specifications. As to physical properties, the only revision deemed necessary by the committee is in the requirements as to elastic limit and percentages of elongation and reduction of area of certain sizes of Class M forgings in the Specifications for Alloy-Steel Forgings which are given in detail in Appendix I.

The committee recommends that these two specifications, in their proposed amended form, be referred to letter ballot of the Society for adoption as standard, with the understanding that the Specifications for Alloy-Steel Forgings, if adopted, will be incorporated with the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings (A 18–14)—No. 1 in the above list.

Proof Tests of Finished Forgings.—In pursuance of a recommendation last year,[1] the report on proof tests of finished forgings accompanying the 1914 report of the committee was published in the 1915 Year-Book. The two specifications for quenched-and-tempered forgings (Nos. 2 and 6) contain the following requirement, with a reference to the report in question:

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 85 (1915).

> "Unless otherwise specified by the purchaser, all forgings shall be subjected to an impact proof test. The details of this test shall be agreed upon by the manufacturer and the purchaser."

The committee believes that the publication of the report in the Year-Book may be discontinued, and recommends that instead an appendix giving briefly the findings of the report, with a reference to Vol. XIV of the Proceedings in which the complete report is published, be added to each of the specifications concerned.

Specifications for Carbon-Steel Car and Tender Axles.—The committee still has under consideration, in cooperation with the Master Car Builders' Association, the matter of revising the drop-test requirements for car and tender axles. Proposed revisions of these requirements, based on the use of a 2240-lb. tup instead of a 1640-lb. tup as at present, have been prepared and new test data are being accumulated for consideration during the year.

ROLLED STEEL WHEELS AND STEEL TIRES (SUB-COMMITTEE VII).

The committee recommends that the three specifications for rolled steel wheels and the specifications for steel tires be revised as indicated below and referred to letter ballot for adoption as standard. In the case of the wheel specifications, the proposed revisions in substance are relatively few; but there have been important changes made in form, notably in the arrangement of the permissible variations in dimensions, which are now presented in more logical order, and for convenience have been tabulated and illustrated in a diagram. In the case of the tire specifications, the proposed changes in substance are more extensive, and changes in form have also been made. It has therefore been considered preferable to append these specifications in their proposed revised form and to call attention in a general way to the changes in substance, rather than to include in Appendix I a complete and necessarily complicated list of changes section by section.

Proposed Revised Standard Specifications for Solid Wrought Carbon-Steel Wheels for Steam Railway Service.—These proposed specifications, which are appended to this report, constitute a revision and combination of the present Standard Specifications for Forged and Rolled, Forged, or Rolled Solid Carbon-Steel Wheels for (*a*) Engine-Truck, Tender and Passenger Service (A 23–12)[1] and (*b*) Freight-Car Service (A 24–12)[2]. It has been felt that the time is opportune for issuing one specification covering all rolled steel wheels for steam railway service, and this has involved but few changes in the substance of the present specifications. These recommended changes are as follows:

(*a*) *Wheels for Engine-Truck, Tender and Passenger Service.*—The requirement that

> "Wheels shall be furnished rough-bored and with hubs faced. They may be furnished with contours as rolled without additional machine work, provided they conform to the dimensions specified by the purchaser within the following tolerances:",

has been changed to read:

> "The wheels shall conform to the dimensions specified within the following permissible variations:".

The requirement as to rotundity has been changed so that the opening between the tread and the ring gage shall not exceed $\frac{1}{16}$ in., instead of $\frac{1}{32}$ in.

(*b*) *Wheels for Freight-Car Service.*—The requirement that

> "The wheels may be furnished with contours as rolled, and shall conform to the dimensions specified within the following tolerances:"

has been changed to read as indicated above.

The variation of the thickness of wall of the hub at any two points on the same wheel has been changed from $\frac{1}{2}$ in. to $\frac{3}{8}$ in.

Proposed Revised Standard Specifications for Solid Wrought Carbon-Steel Wheels for Electric Railway Service.—These proposed specifications, which are appended to this report, are a revision of the present Standard Specifications for Wrought Solid Carbon-Steel Wheels for Electric Railway Service, with Narrow Treads and Small Flanges (A 25–13),[1] in which the following changes are recommended:

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[1] 1915 Year-Book, p. 133.

[2] *Ibid.*, p. 138.

1. *Classes.*—The wheels are in effect divided in the present specifications into two classes, namely, "rolled" and "machined." This sub-division is emphasized in the proposed specifications by the insertion of the sections on "Classes" and "Basis of Purchase," the rolled wheels becoming Class A and the machined wheels Class B. This is virtually a change in form only, and was introduced to clarify the specifications.

2. *Permissible Variations in Dimensions.*—The requirement as to rotundity for Class B wheels has been changed so that the opening between the tread and the ring gage shall not exceed $\frac{1}{64}$ in., instead of $\frac{1}{32}$ in.

The present requirements as to permissible variations in tape sizes (6 tapes over or 4 tapes under the size specified) are made to apply only to wheels with treads under 3 in. in width; for wheels with treads 3 in. or over in width, the permissible variations are 9 tapes over or 5 tapes under the size specified.

The requirements as to thickness of plate have been changed to agree with those of the specifications for wheels for steam railway service.

The permissible variation of the diameter of hub over that specified has been changed from $\frac{5}{8}$ in. to $\frac{3}{4}$ in.

The requirement as to projection of front face of hub has been omitted.

The requirement that

> "The projection of the back face of hub from the gage line shall not vary more than $\frac{1}{32}$ in. over nor more than $\frac{1}{16}$ in. under that specified.",

has been changed to read:

> "The projection of the hub beyond the back face of the rim shall not vary more than $\frac{1}{16}$ in. from that specified."

Marking.—The requirements as to marking have been changed to agree with those of the specifications for wheels for steam railway service.

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[1] 1915 Year-Book, p. 143.

Proposed Revised Standard Specifications for Steel Tires.—These proposed specifications, which are appended to this report, are a revision of the present Standard Specifications for Steel Tires (A 26–14),[1] in which the following changes are recommended:

1. *Chemical Properties and Tests.*—Requirements as to carbon content for each of the three classes have been inserted, as follows:

Class A	0.50 – 0.70 per cent
Class B	0.60 – 0.80 "
Class C	0.70 – 0.85 "

The requirement as to silicon has been changed from "not over 0.35 per cent" to "0.15–0.35 per cent." Finally, it is required that check analysis by the purchaser shall show all the specified chemical elements to meet the requirements, instead of phosphorus and sulfur only, as in the present specifications.

2. *Physical Properties and Tests.*—The drop test has been omitted, and the tension test is required only if specified by the purchaser. (The requirements as to tensile properties have not been changed.) The tension test specimen is taken from an ingot representing each melt; if this specimen fails to conform to the requirements, a second specimen taken from a tire from that melt, furnished at the expense of the manufacturer, may be tested. These requirements differ from those of the present specifications in that the latter provide for a test specimen from the drop-test tire, if specified by the purchaser, and for retests on two additional tires if the results of the physical tests fail to conform to the requirements.

3. *Permissible Variations in Dimensions.*—The requirement as to the permissible variations in inside diameter has been modified so as to always permit a variation of $\frac{1}{4}$ in. less than the diameter specified. The present specifications base the variation on the finished diameter, allowing $\frac{3}{8}$ in. less than this diameter. As a consequence, when tires are ordered rough-bored $\frac{1}{4}$ in. less than the finished inside diameter, the available variation is only $\frac{1}{8}$ in. below the diameter specified.

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[1] 1915 Year-Book, p. 147.

The following permissible variations in outside diameter have been inserted: For tires 54 in. or under in diameter, $\frac{1}{2}$ in. over; for tires over 54 in. in diameter, $\frac{1}{8}$ in. under and $\frac{3}{8}$ in. over the specified diameter.

STEEL CASTINGS (SUB-COMMITTEE VIII).

Proposed Revision in Standard Specifications for Steel Castings.—The revisions recommended by the committee in these specifications are given in Appendix I in such detail as to require no explanation here.

STEEL TUBING AND PIPE (SUB-COMMITTEE IX).

Proposed Revision in Standard Specifications for Lap-Welded and Seamless Steel Boiler Tubes, Safe Ends and Arch Tubes.—The committee recommends that these specifications be revised to include requirements for superheater pipes, the necessary changes for this purpose being given in detail in Appendix I. These specifications in their proposed amended form agree with those to be recommended for adoption by the Master Car Builders' and Master Mechanics' Associations, with whom Sub-Committee IX cooperated in the revision of the specifications.

Standard Specifications for Welded Steel and Wrought-Iron Pipe.—During the past year joint meetings of Sub-Committee IX and a committee of the Master Car Builders' and Master Mechanics' Association have been held, for the object of harmonizing the specifications of the Society for welded pipe (A 53-15) and those of the two associations mentioned. The committee is able to report progress, and will give the question further attention during the coming year.

BOILER STEELS (SUB-COMMITTEE XI).

Proposed Revisions in Standard Specifications for Boiler and Firebox Steel.—In its report last year, the committee announced its intention of "giving special study to the subject of additional tests of boiler plate to determine the uniformity of the metal throughout the plate."[1] This has been done, and the recommended revisions in the Standard Specifications for Boiler and

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 87 (1915).

Firebox Steel (A 30–14) contained in Appendix I provide for the following new features:

(*a*) To check the uniformity of the metal, the tension test specimen is to be taken longitudinally from the bottom and the bend test specimen transversely from the middle of the top of the finished rolled material. (In present practice both are taken longitudinally from the bottom.) The bend test specimen is to be tested cold only, omitting the quench-bend test, and the requirements as to cold bend have been suitably modified.

In addition,

(*b*) The requirements as to permissible variations in weight and thickness have been modified as indicated earlier in the report; and

(*c*) Provision has been made for match-marking of test coupons.

Proposed Tentative Specifications for Boiler and Firebox Steel for Stationary Service.—The committee recommends that these specifications, which are appended to this report, be published as tentative. The presentation of these specifications has resulted from the consideration of the question of revising the Standard Specifications for Boiler and Firebox Steel to agree with the provisions of the Boiler Code drafted by the American Society of Mechanical Engineers, reference to which was made in the report last year.[1]

It was thought best to prepare separate specifications for use in stationary service, to which service the boiler code applies. The proposed Tentative Specifications for Boiler and Firebox Steel for Stationary Service have been modeled upon the Standard Specifications for Boiler and Firebox Steel in their proposed amended form, and contain the three new features referred to above in connection with the latter. In this respect they differ from the specifications in the Boiler Code, and further in the requirements for tensile strength of firebox steel, which in the proposed specifications are 55,000–65,000 lb. per sq. in., while the Boiler Code specifies 55,000–63,000 lb. per sq. in. or, if desired, a steel of lower tensile strength having a range of 8000 lb. per sq. in. Similarly with respect to flange steel: the proposed specifications call for 55,000–65,000 lb. per sq. in., while the Boiler Code specifies that grade or, if desired, a steel of lower tensile strength having a range of 10,000 lb. per sq. in. The committee intends to give further consideration to this feature before recommending that the specifications be adopted as standard.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 87 (1915).

Methods of Chemical Analysis (Sub-Committee XII).

The following two questions involving features in the application of the Standard Methods for Chemical Analysis of Plain Carbon Steel and of Alloy Steels have engaged the attention of Sub-Committee XII:

Agreement between A. S. T. M. and Bauer and Deiss Gravimetric Sulfur Methods.—The findings of the sub-committee on this question have been considered of sufficient importance to warrant their publication as part of this report, and will be found in Appendix II.[1] It is clearly demonstrated that the present A. S. T. M. method gives results well within the limits of accuracy possible under present analytical practice.

Standardization of Arsenite Solutions.—The sub-committee conducted tests to determine the reliability of the procedure outlined in the standard methods for the standardization of arsenite solutions in the determination of manganese, the results of which are given in Appendix III.[2] No change from the present standard is considered necessary, but the committee recommends that the directions for such standardization be made more explicit by the addition of the following sentence after the words "Bureau of Standards' sodium oxalate" in the paragraph entitled "Standard Sodium Arsenite" in the two methods for analysis:[3]

> "Titrate 10-cc. portions of the permanganate solution, to each of which has been added 50-cc. portions of the nitric acid. A clear green color free from brownish or purplish tints will be found a satisfactory and reproducible end-point."

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[1] P. 123.

[2] P. 126.

[3] 1915 Year Book, pp. 209 and 231

This change is not considered to be one of substance, since it is simply explanatory, and therefore its approval will not involve a change in the dates of adoption of the two methods for analysis.

Order of Reporting Chemical Composition of Steel.—The committee has adopted and recommends the following order for reporting chemical composition of steel: Carbon, manganese, phosphorus, sulfur, silicon, copper, nickel, and chromium. It further recommends that percentages of carbon, manganese and silicon be reported to two decimal places and percentages of phosphorus and sulfur to three decimal places. The committee has requested the cooperation of the Association of American Steel Manufacturers in extending the use of these practices.

Test Ingots for Ladle Analysis.—During the past year the tests outlined in the 1915 report[1] have been started, under the direct supervision of Messrs. J. R. Cain and H. S. Rawdon of the U. S. Bureau of Standards. A progress report on these tests is contained in Appendix IV to this report.[2] The investigations will be continued during the coming year.

METHODS OF PHYSICAL TESTS (SUB-COMMITTEE XIII).

The report last year[3] contained the announcement that the question of standard holders for 2-in. tension test specimens would be considered during the year. This matter was formally brought to the attention of the committee in a communication from the Panama Canal Commission pointing out that in many laboratories special holders for 2-in. tension test specimens for steel castings were in use which did not require threading of the ends and which seemed to give entirely satisfactory service. The committee has carefully considered the question, and believes that it is desirable to change the standard of the Society to provide for either filleted shoulders or threaded ends. In detail, the committee recommends that the following requirement in the specifications listed below:

> "Tension test specimens shall be of the form and dimensions shown in Fig. 1,"

be changed to read:

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 88 (1915).

[2] P. 129.

[3] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 89 (1915).

"Tension test specimens shall conform to the essential dimensions shown in Fig. 2. They shall have filleted shoulders, or threaded ends, to fit into the holders on the testing machine in such a way that the line of action of the force exerted by the testing machine shall coincide with the axis of the specimen."

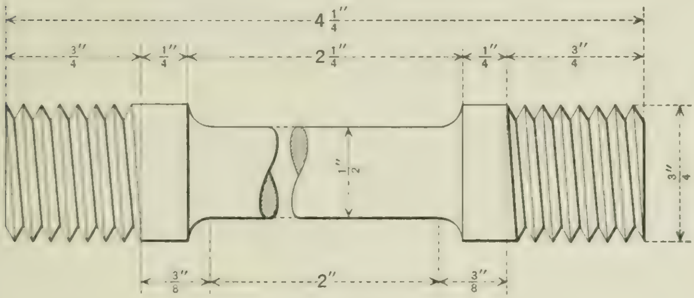
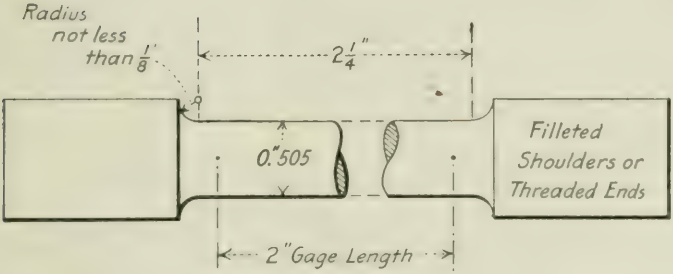


FIG. 1.


Radius not less than 1/8"
2 1/4"
0."505
Filleted Shoulders or Threaded Ends
2" Gage Length

Note:— The Shoulders required when Threaded Ends are not Used may be Formed by the Fillets Terminating the Body or by other Fillets Continuing these, or may be Formed in the Ends beyond these Fillets.

FIG. 2.

It will be noted that the diameter of the specimen is changed from 0.5 to 0.505 in. No special form of holder has been specified, as it is thought that any form that will secure axial loading of the specimen will be satisfactory.

The above recommendation applies to the following specifications for steel: For splice bars and track bolts, A 4–14, A 5–14, A 6–14, A 49–15, A 50–15, A 51–15; for structural steels, A 7–15, A 8–14, A 9–14; for forgings and axles, A 18–14, A 19–14, A 20–14, A 22–14, and tentative specifications; for tires, A 26–14; for castings, A 27–14; and for automobile steels, A 29–15.

In the opinion of the committee, this change is one of form rather than substance, and therefore, if approved by the Society, may be made in the specifications listed without involving a change in the dates of adoption.

LITERARY FORM (SUB-COMMITTEE XV).

The committee believes that the form of wording used at present in the standard ladle and check analyses sections of the various steel specifications may be improved. Since the requirements in the different specifications are not identical, the recommendations of the committee are presented in the form of typical sections, giving the present and proposed wordings in each case:

Ladle Analyses.—Change the present form, namely:

> "An analysis to determine the percentages of .... shall be made by the manufacturer from a test ingot taken during the pouring of each melt, a copy of which shall be given to the purchaser or his representative. This analysis shall conform to the requirements specified in Section .....",

to read:

> "An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of ..... This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section ....."

Check Analyses.—Change the present form, namely:

> "Analyses (*or:* An analysis) may be made by the purchaser from finished material (*or:* from a finished ....) representing each melt, in which case an excess of .... per cent above the requirements specified in Section .... shall be allowed. (*or:* which shall conform to the requirements specified in Section .....),"

to read:

> "Analyses (*or:* An analysis) may be made by the purchaser from finished material (*or:* from a finished ....) representing each melt. The .... (phosphorus, etc.) content thus determined shall not exceed that specified in Section .... by more than .... per cent. (*or:* The chemical composition thus determined shall conform to the requirements specified in Section .....)"

These changes, if approved, will not involve a change in the dates of adoption of the specifications affected, since in making them the substance of the specifications is not to be changed in any way.

Attention is called to the necessity of using the form "An analysis, etc." instead of "Analyses, etc." as at present in the sections on check analyses in the following specifications, in order to express the intent more clearly: For splice bars and track bolts, A 3–14, A 4–14, A 5–14 A 6–14, A 49–15, A 50–15, A 51–15; for bars for springs, A 14–14, and tentative specifications; for billets, forgings and axles, A 17–13, A 18–14, A 19–14, A 20–14, A 21–14, A 22–14, and tentative specifications; for boiler steel, A 30–14.

MISCELLANEOUS ANNOUNCEMENTS.

In addition to questions now under consideration and previously referred to, the following new matters will be taken up during the year by the committee through the appropriate sub-committees:

Sub-Committee I.—Specifications for Steel Ties.

Sub-Committee III.—Special requirements for permissible variations in weight and thickness of sheared plates for ship use.

Sub-Committee XIII.—Order and manner of reporting the various physical properties of steel, and the method of describing the character of fracture.

This report has been submitted to letter ballot of the committee, which consists of 97 members, of whom 84 have voted affirmatively, 3 negatively, and 10 have refrained from voting.

Respectfully submitted on behalf of the committee,

C. D. YOUNG,
Chairman.

C. L. WARWICK,
Secretary.

APPENDIX I.

PROPOSED REVISIONS IN STANDARDS AND TENTATIVE STANDARDS FOR STEEL AND STEEL PRODUCTS.

In this appendix are given in detail the revisions recommended by Committee A-1 in certain Standards and Tentative Standards for steel and steel products. After the title of each standard and tentative standard is given its serial designation (if any) and page number in the 1915 Year-Book, where it appears in its present form.

STRUCTURAL STEEL.

SPECIFICATIONS FOR STRUCTURAL STEEL FOR BRIDGES: A 7–15 (page 55);

SPECIFICATIONS FOR STRUCTURAL NICKEL STEEL: A 8–14 (page 62);

SPECIFICATIONS FOR STRUCTURAL STEEL FOR BUILDINGS: A 9–14 (page 69);

SPECIFICATIONS FOR STRUCTURAL STEEL FOR LOCOMOTIVES: A 10–14 (page 75);

SPECIFICATIONS FOR STRUCTURAL STEEL FOR CARS: A 11–14 (page 80);

SPECIFICATIONS FOR STRUCTURAL STEEL FOR SHIPS: A 12–14 (page 85).

In each of the above specifications, change the present requirements as to permissible variations in weight and thickness to read:

"The cross-section or weight of each piece of steel shall not vary more than 2.5 per cent from that specified; except in the case of sheared plates, which shall be covered by the following permissible variations. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

TABLE I.—PERMISSIBLE VARIATIONS OF PLATES ORDERED TO WEIGHT.

ORDERED WEIGHT, LB. PER SQ. FT.	PERMISSIBLE VARIATIONS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, EXPRESSED IN PERCENTAGES OF ORDERED WEIGHTS.																		ORDERED WEIGHT, LB. PER SQ. FT.
	Under 48 in.		48 to 60 in., excl.		60 to 72 in., excl.		72 to 84 in., excl.		84 to 96 in., excl.		96 to 108 in., excl.		108 to 120 in., excl.		120 to 132 in., excl.		132 in. or over.		
	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	Over.	Under.	
Under 5	5	3	5.5	3	6	3	7	3	...	...	...	...	...	...	...	...	...	...	Under 5
5 to 7.5 excl	4.5	3	5	3	5.5	3	6	3	...	...	...	...	...	...	...	...	...	...	5 to 7.5 excl.
7.5 " 10 "	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	...	...	...	...	7.5 " 10 "
10 " 12.5 "	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	9	3	10 " 12.5 "
12.5 " 15 "	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	8	3	12.5 " 15 "
15 " 17.5 "	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	7	3	15 " 17.5 "
17.5 " 20 "	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	6	3	17.5 " 20 "
20 " 25 "	2	2	2.5	2	2.5	2.5	3	2.5	3.5	2.5	4	3	4.5	3	5	3	5.5	3	20 " 25 "
25 " 30 "	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	5	3	25 " 30 "
30 " 40 "	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	4.5	3	30 " 40 "
40 or over	2	2	2	2	2	2	2	2	2.5	2	2.5	2.5	3	2.5	3.5	3	4	3	40 or over

NOTE.—The weight per square foot of individual plates shall not vary from the ordered weight by more than 1⅓ times the amount given in this table.

TABLE II.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS.

ORDERED THICKNESS, IN.	PERMISSIBLE EXCESS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, EXPRESSED IN PERCENTAGES OF NOMINAL WEIGHTS.									ORDERED THICKNESS, IN.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in. or over.	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	.	1/8 to 3/16 excl.
3/16 " 1/4 "	7	8	9	10	12	..	..	..	..	3/16 " 1/4 "
1/4 " 5/16 "	6	7	8	9	10	12	14	16	19	1/4 " 5/16 "
5/16 " 3/8 "	5	6	7	8	9	10	12	14	17	5/16 " 3/8 "
3/8 " 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 " 7/16 "
7/16 " 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 " 1/2 "
1/2 " 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 " 5/8 "
5/8 " 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 " 3/4 "
3/4 " 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 " 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

(*a*) *When Ordered to Weight per Square Foot:* The weight of each lot[1] in each shipment shall not vary from the weight ordered more than the amount given in Table I.

(*b*) *When Ordered to Thickness:* The thickness of each plate shall not vary more than 0.01 in. under that ordered.

The overweight of each lot[2] in each shipment shall not exceed the amount given in Table II."

SPECIFICATIONS FOR STRUCTURAL STEEL FOR CARS: A 11–14 (page 80).

1. *Section 6* (*a*).—Change the requirement as to tensile strength of rivet steel from "48,000–58,000 lb. per sq. in." to "45,000–60,000 lb. per sq. in."

2. *Sections 3, 6* (*a*) *and 8* (*b*).—Change the term "Plates for Cold Flanging" to read: "Plates for Cold Pressing."

3. *Section 11.*—Change the requirements as to permissible variations in weight and thickness as indicated above.

SPRING STEEL.

SPECIFICATIONS FOR CARBON-STEEL BARS FOR RAILWAY SPRINGS: A 14–14 (page 95).

TENTATIVE SPECIFICATIONS FOR SILICO-MANGANESE-STEEL BARS FOR AUTOMOBILE AND RAILWAY SPRINGS (page 489).[3]

TENTATIVE SPECIFICATIONS FOR CHROME-VANADIUM-STEEL BARS FOR AUTOMOBILE AND RAILWAY SPRINGS (page 492).[3]

In Section 6 of each of the above specifications, omit all of the present requirements as to permissible variations in dimensions and substitute the following:

"6. The permissible variations in the width and thickness of the bars shall be agreed upon by the manufacturer and the purchaser."

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[1] The term "lot" applied to Table I means all of the plates of each group width and group weight.

[2] The term "lot" applied to Table II means all of the plates of each group width and group thickness.

[3] The committee is recommending that these specifications as amended, be adopted as standard.

FORGINGS AND COLD-ROLLED AXLES.

SPECIFICATIONS FOR CARBON-STEEL AND ALLOY-STEEL FORGINGS: A 18–14 (page 108).

1. *Section 10 (d).*—Change from its present form, namely:

> "(*d*) The elastic limit shall be determined by means of an extensometer.",

to read:

> "(*d*) The elastic limit called for by these specifications shall be determined by an extensometer reading to 0.0002 in. The extensometer shall be attached to the specimen at the gage marks and not to the shoulders of the specimen nor to any part of the testing machine. When the specimen is in place and the extensometer attached, the testing machine shall be operated so as to increase the load on the specimen at a uniform rate. The observer shall watch the elongation of the specimen as shown by the extensometer and shall note, for this determination, the load at which the rate of elongation shows a sudden increase. The extensometer shall then be removed from the specimen, and the test continued to determine the tensile strength."

2. Revise so as to include the requirements of the Tentative Specifications for Alloy-Steel Forgings, if these are adopted as standard, as the committee is recommending.

SPECIFICATIONS FOR QUENCHED-AND-TEMPERED CARBON-STEEL AXLES, SHAFTS, AND OTHER FORGINGS FOR LOCOMOTIVES AND CARS: A 19–14 (page 115).

1. *Section 5* (*a*).—Change to read as follows by the insertion of the italicized words:

> "5. (*a*) Unless otherwise specified by the purchaser, all forgings over 7 in. in diameter shall be bored, *and all axles, shafts and similar forgings shall be rough-turned all over*. The boring *and rough turning* shall be done before quenching."

2. *Section 10* (*c*). Make the same change as in Section 10 (*d*) of Specification A 18–14 above.

3. *Section 15* (*b*).—Add the following sentence:

> "The fracture shall be considered crystallin if the crystals which it contains are so large that the cleavage planes or sides of these crystals are easily visible to the eye."

TABLE I.—TENSILE PROPERTIES.

FOR FORGINGS WHOSE MAXIMUM OUTSIDE DIAMETER OR THICKNESS IS NOT OVER 10 IN. WHEN SOLID, AND NOT OVER 20 IN. WHEN BORED.

CLASS.	SIZE.	Tensile Strength, min., lb. per sq. in.	Elastic Limit, min., lb. per sq. in.	Elongation in 2 in., min., per cent.	Reduction of Area, min., per cent.
M ALLOY STEEL, QUENCHED AND TEMPERED.	Up to 2 in. in outside diameter or thickness, 1-in. max. wall.	125 000	110 000 *(105 000)*	18 *(16)*	50
	Over 2 to 4 in. in outside diameter or thickness, 2-in. max. wall	115 000	100 000 *(95 000)*	18 *(16)*	50 *(45)*
	Over 4 to 7 in. in outside diameter or thickness, 3½-in. max. wall	110 000	90 000 *(85 000)*	18 *(16)*	45
	Over 7 to 10 in. in outside diameter or thickness, 5-in. max. wall	100 000	80 000 *(75 000)*	18	45
	Outside diameter or thickness not over 20 in., 5 to 8-in. wall	100 000	80 000 *(70 000)*	18	45

4. *Section 16*.—Change the second sentence to read as follows, by the insertion of the italicized words and the omission of the phrase in brackets:

> "Axles, shafts and similar forgings, unless otherwise specified, shall be rough-turned *all over* with an allowance of ⅛ in. on the surface for finishing. [, except on the collars of axles or other forgings, which shall be left rough-forged.]

SPECIFICATIONS FOR CARBON-STEEL FORGINGS FOR LOCOMOTIVES: A 20–14 (page 121).

Section 12 (*b*).—Add the same sentence as for Section 15 (*b*) of Specification A 19–14 above.

SPECIFICATIONS FOR COLD-ROLLED STEEL AXLES: A 22–14 (page 129).

Section 6 (*b*).—Make the same change as in Section 10 (*d*) of Specification A 18–14 above.

TENTATIVE SPECIFICATIONS FOR ALLOY-STEEL FORGINGS (page 506).[1]

1. *Section 10* (*a*).—In Table I, Class M, "Alloy Steel, Quenched and Tempered," substitute the values given in italics for those immediately above them.

2. *Section 10* (*c*).—Make the same change as in specification A 18–14 above.

TENTATIVE SPECIFICATIONS FOR QUENCHED-AND-TEMPERED ALLOY-STEEL AXLES, SHAFTS, AND OTHER FORGINGS FOR LOCOMOTIVES AND CARS (page 512).[2]

1. *Section 10* (*c*).—Make the same change as in Section 10 (*d*) of Specification A 18–14 above.

2. *Section 15* (*b*)—Add the same sentence as for Section 15 (*b*) of Specification A 19–14 above.

CASTINGS.

SPECIFICATIONS FOR STEEL CASTINGS: A 27–14 (page 154).

1. *Section 5* (*b*).—Change from its present form, namely:

> "(*b*) Class B castings shall be allowed to become cold. They shall then be uniformly reheated to the proper temperature to refine the grain (a group thus reheated being known as an "annealing charge"), and allowed to cool uniformly and slowly. If, in the opinion of the purchaser or his representative, a casting is not properly annealed, he may at his option require the casting to be re-annealed.",

to read:

> "(*b*) Class B castings shall be properly annealed, the treatment depending upon the design and chemical composition of the castings."

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[1] The committee is recommending that these specifications, as amended, be adopted as standard, and made a part of the Standard Specifications A 18-14.

[2] The committee is recommending that these specifications, as amended, be adopted as standard.

2. *Section 9 (a).*—Change the minimum requirements as to yield point for all grades of castings to read: "45 per cent of the tensile strength."

3. *Section 11.*—Change to read as follows by the insertion of the italicized words:

> "11. In the case of small or unimportant castings, a test to destruction on three castings from a lot may, *upon agreement between the manufacturer and the purchaser*, be substituted for the tension and bend tests. This test shall show the material to be ductile, free from injurious defects, and suitable for the purpose intended. *Unless otherwise agreed upon between the manufacturer and the purchaser*, a lot shall consist of all castings from one melt, in the same annealing charge."

4. Insert after Section 13 the following new Section 14 on Retests, changing the numbers of succeeding sections accordingly:

> "14. If the results of the physical tests of any test lot do not conform to the requirements specified, the manufacturer may re-anneal such lot not more than twice and retests shall be made as specified in Sections 9 and 10."

5. *Section 15 (c).* Change from its present form, namely:

> "(*c*) The castings offered for inspection shall not be painted or covered with any substance that will hide defects, nor rusted to such an extent as to hide defects.",

to read:

> "(*c*) Castings shall not be offered for inspection if covered with paint, rust, or any other substance to such an extent as to hide defects."

BOILER TUBES.

SPECIFICATIONS FOR LAP-WELDED AND SEAMLESS STEEL BOILER TUBES, SAFE ENDS, AND ARCH TUBES: A 28–13 (page 160).

1. Change the title to read:

> "Lap-Welded and Seamless Steel Boiler Tubes, Boiler Flues, Superheater Pipes, Safe Ends, and Arch Tubes for Locomotives."

2. *Section 4 (a).*—Insert at the beginning of the first sentence: "For all tubes except superheater pipes,".

3. *Section 5.*—Change to read as follows, by the insertion of the italicized words and the omission of the word in brackets:

> "5. (*a*) *For all tubes except superheater pipes,* a test specimen 4 in. in length shall stand *flattening or* hammering [flat] until the inside *of the* walls are in contact, without cracking at the edges or elsewhere. For lap-welded tubes, care shall be taken that the weld is not located at the point of maximum bending.
>
> "*(b) For superheater pipes, a test specimen 4 in. in length shall stand flattening by pressure or hammering until the distance between the inside of the walls is equal to twice the thickness of the material, without cracking at the edges or elsewhere.*"

4. *Section 6.*—Change to read as follows by the insertion of the italicized words:

> "6. (*a*) *For all tubes except superheater pipes,* a test specimen $2\frac{1}{2}$ in. in length shall stand crushing longitudinally until the outside folds are in contact, without showing cracks or flaws.
>
> "*(b) For superheater pipes, a test specimen $2\frac{1}{2}$ in. in length shall stand crushing longitudinally down to $1\frac{1}{4}$ in., without showing cracks or flaws.*"

5. *Section 11.*—Change the present table of standard weights to read as indicated in the accompanying table, by the addition of the values shown in italics, and the new table for small superheater pipes.

6. *Section 13.*—Insert the following sentence after the second sentence:

> "In the case of boiler tubes which are expanded and swaged, the thickness of the expanded end may be $1\frac{1}{2}$ gages lighter, and of the swaged end 2 gages heavier than the thickness specified."

7. *Section 17 (b).*—Change to read as follows, by the insertion of the italicized words and the omission of the words in brackets:

LAP-WELDED AND SEAMLESS STEEL BOILER TUBES.

INCLUDING SAFE ENDS, ARCH TUBES AND LARGE BOILER TUBES.

THICKNESS.		WEIGHT, LB. PER FT. OF LENGTH. Outside Diameter, in.													
In.	Nearest B. w. g. or Fraction.	$1\frac{3}{4}$	$1\frac{7}{8}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{1}{2}$	6
0.095	13	1.679	1.806	1.932	2.186	2.440	....	....	....	....	....	....	......	......	......
0.110	12	1.926	2.073	2.220	2.514	2.807	3.895	..	..	....	..	..	......	......	......
0.125	11	2.169	2.336	2.503	2.836	3.170	3.838	4.505	.....	..	..	....	......	......	......
0.135	10	2.328	2.508	2.688	3.049	3.409	4.130	4.851	5.572	.	...	....	......	......	......
0.150	9	2.560	.....	2.960	3.360	3.760	4.565	5.366	6.167	6.968	7.769	8.170	8.370	8.570	9.370
0.156	$\frac{5}{32}$	.....	....	....	.	...	4.745	5.579	6.414	7.248	8.083	8.500	8.708	8.917	......
0.165	8	....	..	.....	..	4.110	4.995	5.877	6.758	7.639	8.520	8.960	9.181	9.401	10.282
0.180	7	.....	....	.	....	4.460	5.421	6.382	7.348	8.304	9.266	9.746	9.987	10.227	11.188
0.187	$\frac{3}{16}$	.....	...	...	...	..	5.632	6.633	7.634	8.635	9.637	10.137	10.388	10.638	11.689

SMALL SUPERHEATER PIPES.

SEAMLESS ONLY.

THICKNESS.		WEIGHT, LB. PER FT. OF LENGTH. Outside Diameter, in.											
In.	Nearest B. w. g. or Fraction.	$\frac{5}{8}$	$\frac{11}{16}$	$\frac{3}{4}$	$\frac{13}{16}$	$\frac{7}{8}$	$\frac{15}{16}$	1	$1\frac{1}{4}$	$1\frac{3}{8}$	$1\frac{7}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$
0.095	13	0.5375	0.6012		..	....	....	...	..	.	.	...	...
0.109	12		.	0.7462	0.8190	....	...	....	...	..	...	....	....
0.120	11	.	...	...	.	0.9676	1.0480	1.1280	....	....	....	...	....
0.135	10	.		..	.	....	....	....	1.6100	1.7900	1.8800	1.9700	2.1500
0.150	9	....	....	....	....	..	.....	....	1.7600	1.9600	2.0600	2.1600	2.3600
0.156	$\frac{5}{32}$	....	....	....	....	....	.....	....	1.9100	2.1300	2.2400	2.3500	2.5700

"(*b*) Tubes when inserted in the boiler shall stand expanding and beading without showing cracks or flaws, or opening at the weld. *Superheater pipes when properly manipulated shall stand all forging, welding and bending operations necessary for application without developing defects.* Tubes *or superheater pipes* which fail in [this manner] *either of the above operations* will be rejected, and the manufacturer shall be notified."

BOILER STEEL.

SPECIFICATIONS FOR BOILER AND FIREBOX STEEL: A 30–14 (page 181).

1. Change the title to read:

"Boiler and Firebox Steel for Locomotives."

2. *Section 8* (*a*).—Change the following sentence:

"For material 1 in. or under in thickness, flat on itself; and for material over 1 in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen.",

to read:

"For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen."

3. *Section 8* (*b*) *on Quench-bend Tests.*—Omit.

4. *Section 10.*—Change the first sentence, namely:

"Tension and bend test specimens shall be taken from the finished rolled material.",

to read:

"Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middel of the top of the finished rolled material. The longitudinal test specimens shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimens at right angles to that axis."

5. *Section 11* (*a*).—Change from its present form, namely:

> "(*a*) One tension, one cold-bend, and one quench-bend test shall be made from each plate as rolled.",

to read:

> "(*a*) One tension and one bend test shall be made from each plate as rolled."

6. *Section 12.*—Change the present requirements as to permissible variations in weight and thickness to read:

"12. *When Ordered to Thickness.*—The thickness of each plate shall not vary more than 0.01 in. under that ordered.

The overweight of each lot[1] in each shipment shall not exceed the amount given in Table I. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS.

ORDERED THICKNESS, IN.	PERMISSIBLE EXCESS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, EXPRESSED IN PERCENTAGES OF NOMINAL WEIGHTS.									ORDERED THICKNESS, IN.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108 in., excl.	108 to 120 in., excl.	120 to 132 in., excl.	132 in or over.	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	..	1/8 to 3/16 excl.
3/16 " 1/4 "	7	8	9	10	12	..	..	..	..	3/16 " 1/4 "
1/4 " 5/16 "	6	7	8	9	10	12	14	16	19	1/4 " 5/16 "
5/16 " 3/8 "	5	6	7	8	9	10	12	14	17	5/16 " 3/8 "
3/8 " 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 " 7/16 "
7/16 " 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 " 1/2 "
1/2 " 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 " 5/8 "
5/8 " 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 " 3/4 "
3/4 " 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 " 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

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[1] The term "lot" applied to Table I means all of the plates of each group width and group thickness.

7. *Section 14.*—Change the present section to Section 14 (*a*), and add the following new paragraphs:

> "(*b*) When specified on the order, plates shall be match-marked as defined in Paragraph (*c*) so that the test specimens representing them may be identified. When more than one plate is sheared from a single slab or ingot, each shall be match-marked so that they may all be identified with the test specimens representing them.
>
> "(*c*) Each match mark shall consist of two overlapping circles each not less than $1\frac{1}{2}$ in. in diameter, placed upon the shear lines, and made by separate impressions of a single-circle steel die.
>
> "(*d*) Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted."

APPENDIX II.

REPORT ON COOPERATIVE ANALYSIS OF A LOW-SULFUR TOOL STEEL.

Submitted by Sub-Committee XII, on Methods of Chemical Analysis, of Committee A-1.

A sample of low-sulfur, straight-carbon tool steel was submitted to the chairman of Sub-Committee XII of Committee A-1 by Mr. J. A. Capp, Chief of Testing Laboratory, General Electric Co., Schenectady, N. Y., together with a set of sulfur determinations made by the chemical aboratories of that company and by thirteen other laboratories. The sulfur contents reported by the latter ranged from 0.008 to 0.022 per cent, the methods used not being specified. The percentages of sulfur obtained by the laboratories of the General Electric Co. were as follows:

G. E. routine methods; by routine analyst; six determinations	0.017	per cent
G. E. standard gravimetric method; by foreman of laboratory; two determinations	0.015	"
A. S. T. M. standard gravimetric method; two determinations	0.0112	"
Bauer and Deiss ether-extraction method; two determinations	0.0137	"

The average of the results reported by all analysts was 0.0139 per cent.

The sample was divided and portions sent to Mr. J. H. Gibboney, Chief Chemist, Norfolk and Western Railroad Co., Roanoke, Va.; Mr. Wm. Brady, Chief Chemist, Illinois Steel Co., South Chicago, Ill.; and Mr. J. R. Cain, Associate Chemist, Bureau of Standards, Washington, D. C. Results for sulfur were obtained by the A. S. T. M. gravimetric method and by the Bauer and Deiss ether-extraction method. An abstract of the latter method from the original German text follows:

BAUER AND DEISS' ETHER-EXTRACTION METHOD FOR DETERMINING SULFUR IN STEEL.

Cover 8 to 10 g. of steel in a round-bottom flask with 70 to 90 cc. of concentrated HNO_3, sp. gr. 1.42. Heat carefully until oxides of nitrogen begin to be evolved. A basin of cold water should be conveniently at hand to arrest the action by cooling should it become too violent. Continue the heating and when solution is complete, evaporate to dryness and decompose the nitrates by baking. After taking up the residue in concentrated hydrochloric acid and evaporating to dryness in the flask for separation of silica, again dissolve the residue in hydrochloric acid. Filter off the silica and wash it with dilute hot hydrochloric acid until iron-free. Take the filtrate to low bulk and then extract with ether in the usual way.[1] Heat the aqueous solution freed from all but traces of iron, to expel the ether, and then evaporate to dryness. Take the residue up with a little hydrochloric acid, filter the solution if necessary, and wash the filter well.[2] If the volume now exceeds from 20 to 40 cc. reduce it by evaporation to that amount, heat to boiling, and precipitate the sulfur with barium chloride. After standing several hours in a warm place the supernatant fluid becomes clear; after cooling, filter through a small filter, wash carefully with dilute hydrochloric acid, and then with water. Burn the filter paper and precipitate in a weighed platinum crucible and weigh. Calculate the percentage of sulfur from the weight of barium sulfate found.

Very careful blanks must be run, using the same amounts of acid, ether, etc., as used when making a determination.

The results obtained by Messrs. Gibboney, Brady and Cain are given in Table I.

It will be seen that the average result by the A. S. T. M. method as practiced by these three laboratories differs from the average reported by Mr. Capp for all laboratories by only 0.0007 per cent; that the unweighted average results of the three sub-committee laboratories by the Bauer and Deiss and the A. S. T. M. methods differ by only 0.0005 per cent; and that the average result of the three analysts by all methods (0.013 per cent) differs from the unweighted average of the General Electric Co. by all methods (0.014 per cent) by 0.001 per cent. All of these summarized results are considered by the sub-committee as well within the limitations of the methods and of present analytical practice.

It will also be noted that by excluding the following obviously erroneous results submitted by certain of the other laboratories,

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[1] See Blair for details if not familiar with them.

[2] It is recommended by Cain that the strength HCl recommended by the A. S. T. M. be used for washing the barium sulfate, namely, 2 cc. of concentrated HCl per 100 cc. of water.

0.017, 0.008, 0.017, 0.022 and 0.017 per cent, the general (unweighted) average becomes 0.0129 per cent, a result differing from the sub-committee general average by 0.0001 per cent. This agreement is of course far beyond the limitation of the methods used by the sub-committee, which is probably in the neighborhood of ±0.002 per cent on this class of material. The probable accuracy for gravimetric sulfur methods given by Bauer and Deiss,[1] using a 10-g. sample of steel containing 0.01 to 0.04 per cent of sulfur is ±0.002 per cent.

TABLE I.—PERCENTAGES OF SULFUR.

Analyst.	A. S. T. M. Method.		Ether-Extraction Method.	
	Method, per cent.	Blank.	Method, per cent.	Blank.
Gibboney	0.0126 0.0110	0.8 mg. $BaSO_4$ for 10-g. sample.	0.0131 0.0137	1.6 mg. $BaSO_4$ for 10-g. sample.
Aver.	0.0118		0.0134	
Brady	0.014 0.014		0.015 0.014 0.014	
Aver.	0.014		0.014	
Cain	0.0126 0.0148	Negligible.	0.0112 0.0109	1.9 mg. $BaSO_4$.
Aver.	0.014		0.011	
	....		0.0120 0.0107	Negligible, the ether being purified from SO_3.
Aver.	......		0.011	
Average of all analysts	0.0132		0.0127	

NOTE.—The average of all results was 0.013 per cent.

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[1] "Probenahme und Analyse von Eisen und Stahl," First Edition, p. 188.

APPENDIX III.

REPORT ON PROCEDURE FOR STANDARDIZING ARSENITE SOLUTIONS FOR MANGANESE DETERMINATIONS BY THE A.S.T.M. STANDARD METHOD.

Submitted by Sub-Committee XII, on Methods of Chemical Analysis, of Committee A-1.

The question was brought before Sub-Committee XII of Committee A-1 as to the exact procedure intended by the statement under the heading "Standard Sodium Arsenite" in the Determination of Manganese by the Bismuthate Method,[1] wherein the operator is directed to "titrate against potassium permanganate solution (about N/10), which has been standardized by using Bureau of Standards sodium oxalate."

Attention was called to the fact that this standardization might be made directly, or indirectly, as through the use of arsenite solution which had been compared with permanganate solution standardized in the way prescribed; if made directly, different results might be obtained when working in neutral, alkaline, and acid solutions, etc. It was also stated that a different standard was obtained in this way than when standardizing the arsenite solution against a steel of known manganese content.

The direct standardization against permanganate was the one intended by the sub-committee; accordingly a more explicit set of directions for this standardization was prepared and sent to Mr. H. A. Hosmer, Chemist, Cambria Steel Co.; Mr. George A. Hopkins, Metallurgist, Carnegie Steel Co.; Mr. William

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[1] "Standard Methods for Chemical Analysis of Plain Carbon Steel" (Serial Designation: A 33–14), 1915 Year-Book, p. 209; also, "Standard Methods for Chemical Analysis of Alloy Steels" (Serial Designation: A 55–15), *ibid.*, p. 231.

Brady, Chief Chemist, Illinois Steel Co.; and Mr. J. R. Cain, Associate Chemist, Bureau of Standards; all members of the subcommittee. There were also sent to each of these members a bottle of Bureau of Standards sodium oxalate with directions for its use, and a bottle of Bureau of Standards Standard Steel No. 13*a*, containing 0.630 per cent of manganese. It was directed that arsenite solutions should be standardized directly against this steel, using the bismuthate method as described in 1915 Year-Book (page 209), and that the same arsenite solutions should then be standardized against a permanganate solution, in turn standardized against Bureau of Standards sodium oxalate as directed in Bureau of Standards Circular No. 40, and the results of both standardizations reported. The directions on this point were as follows:

TABLE I.—RESULTS OF COOPERATING ANALYSTS ON STANDARDIZING ARSENITE SOLUTIONS.

VALUES IN GRAMS OF MANGANESE.

Analyst.	Against $KMnO_4$ *vs.* B. S. Sodium Oxalate.	Against Bureau of Standards Standard Steel, No. 13*a*.	Difference, Column 3 minus Column 2.
Brady	0.000965	0.000969	+0.000004
	0.0001915	0.0001914	−0.0000001
Cain	0.0005854	0.0005860	+0.0000007
Hopkins	0.001302	0.001323	+0.000021
	0.0009945	0.001008	+0.000014
Hosmer	0.000956	0.000952	−0.000004

> About N/10 $KMnO_4$ is a convenient strength. Titrate 10-cc. portions of the permanganate, to each of which has been added 50-cc. portions of the 1.135 specific-gravity acid. A clear green color, free from brownish or purplish tints, will be found a satisfactory and reproducible end-point.

The figures reported by the four members of the sub-committee are given in Table I.

The results show that both methods of standardizing arsenite solutions yield very concordant results, and inasmuch as the direct standardization against permanganate is much more convenient, it is recommended that the procedure of the Society be retained, but that it be made more explicit by inserting just after the words "which has been standardized by using Bureau of Standards sodium oxalate," the following sentences:

> "Titrate 10-cc. portions of the permanganate to each of which has been added 50-cc. portions of the nitric acid. A clear green color, free from brownish or purplish tints, will be found a satisfactory and reproducible end-point."

APPENDIX IV.

REPORT ON INVESTIGATION OF LADLE-TEST STEEL INGOTS.

By J. R. Cain and H. S. Rawdon.

Purpose and Plan of the Investigation.

The present investigation was taken up by Sub-Committee XII of Committee A-1 of the Society as being a subject closely allied to its work on standardization of methods for chemical analysis of steel. Preliminary inquiries had developed the fact that there was great diversity in the shapes and sizes of test ingots in current use by steel manufacturers, and it was felt that it might be possible to recommend certain standard types. Accordingly, inquiries were addressed by the chairman of the sub-committee to a number of steel manufacturers, asking for the following information:

1. Size and shape of test ingots;
2. Number of test ingots per heat and time when poured;
3. Place and size of drill holes bored in obtaining drillings for analysis; and
4. Size and shape of ingot molds.

Fig. 1 shows the types of ingots in use as disclosed by this inquiry. Sixteen of the companies replying to these inquiries use the frustrum of pyramid form (Class A), eight the frustrum of cone (Class B), four the hemispherical (Class C), four the prism (Class D), three the prism with pouring head (Class E), two the wedge (Class F) and two the cylindrical (Class G).

As soon as this information was at hand it was seen that no recommendations as to standard ingot types could be made until there had been some study of the properties of the various types in use. It was believed that this could best be made by a metallographic study of split ingots for soundness and segregation, and by a chemical study of segregation on a companion set of ingots. In order that conditions such as pouring tempera-

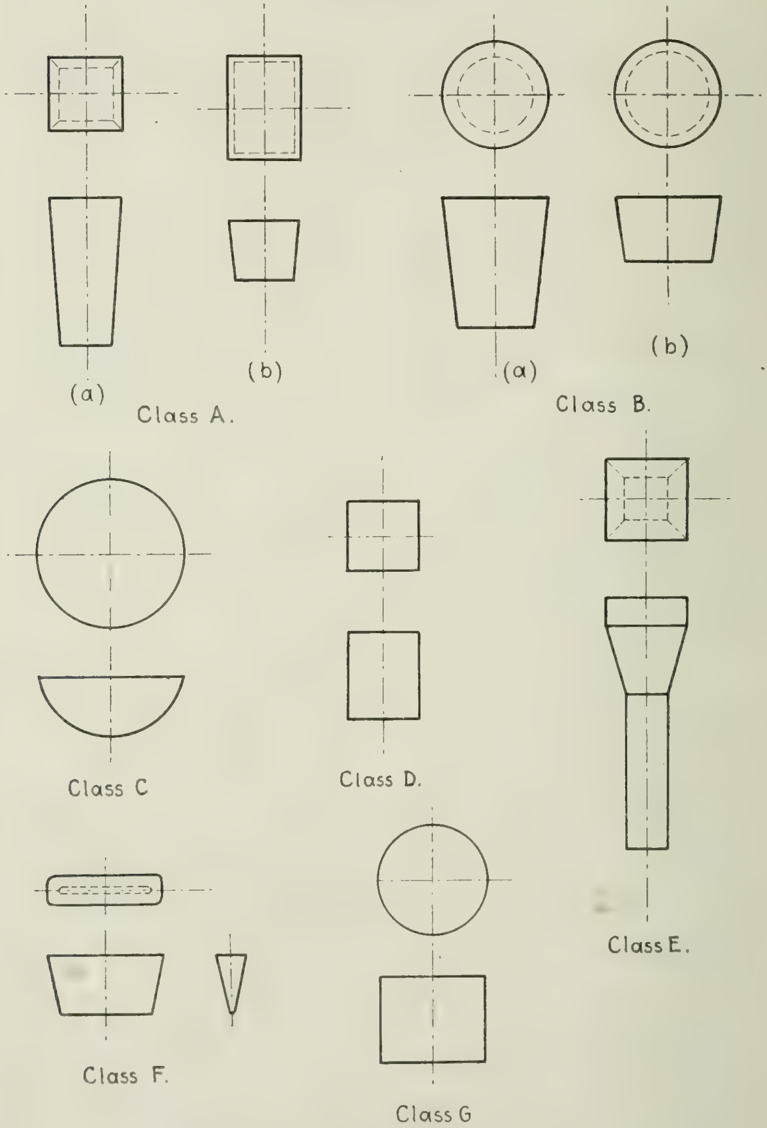


FIG. 1.—Classes of Ladle Ingots.

ture, temperature of molds, rate of filling, etc., might correspond to the manufacturer's practice, it was deemed best that the first set of ingots examined should be made in each case by the manufacturer himself. Accordingly, the cooperation of the steel companies was enlisted to the extent of preparing test ingots in a specified manner. The essential details of the method designated are given in the following extracts from the set of instructions sent to each manufacturer:

"*Grades Wanted.*—Grade No. 1, carbon 0.20 per cent; grade No. 2, carbon 0.40 per cent; grade No. 3, carbon 0.70 per cent; and grade No. 4, carbon 1.00 per cent. If all grades are not made, please furnish those which you regularly manufacture.

"*Number of Ingots Wanted.*—Four from each grade of steel.

"*Kind of Steel.*—Basic open-hearth.

"*Heat Treatment of Ingots.*—Of grades Nos. 3 and 4, three ingots are to be annealed.

"*Metallurgical Treatment of Ingots.*—No additions such as aluminum, silicon, ferro-alloys, etc., are to be made at or after pouring the test ingots.

"*Further Treatment of Ingots.*—One ingot from each is to be sawed longitudinally in halves with a hacksaw.

"*Ladle Analysis of Heat.*—Please furnish the ladle analysis made according to the usual procedure of your laboratory for carbon, manganese, phosphorus, sulfur, and silicon for the heat from which the test ingots were poured."

Seventeen firms submitted ingots made in accordance with instructions. These were constituted as follows:

Number of sets of grade No. 0 (very low carbon)	2
" " " " " " 1 (0.15–0.25 per cent carbon)	16
" " " " " " 2 (0.35–0.45 " ")	11
" " " " " " 3 (0.65–0.75 " ")	10
" " " " " " 4 (0.90–1.10 " ")	8
" " " " " " 1, 2, 3 and 4 to which aluminum was added	6

The ingots received from the various manufacturers have been numbered in Roman numerals from I to XVII, with the grade according to carbon content indicated by Arabic numerals following. Thus, XVI-2 indicates an ingot of grade No. 2, containing from 0.35–0.45 per cent of carbon. For convenient reference, the complete list of ingots, showing the classes to which they belong, is given in Table I.

The work is being done by the Bureau of Standards, under the direction of Mr. J. R. Cain, Associate Chemist, and Mr. H. S. Rawdon, Assistant Physicist (Metallography).

METALLOGRAPHIC EXAMINATION.

The metallographic examination was carried out along the lines indicated below.

Macroscopic Examination.—Macroscopic examination was made of the cut faces of sections taken along a medial plane, the aim being to show the number, distribution, and relative size of blow-holes and gas cavities. In Figs. 2 and 3 (Plates I and II) are shown sections of the various forms chosen for chemical analysis and these are very representative of the whole series examined. In Table II are given the results of the examination of a series of about one-third the total number which were chosen at random, split on a plane one-third the distance of the height from the bottom of the ingot (except in tall narrow forms in which a medial section was used), the holes being counted in the cut section and their character noted.

TABLE I.—LIST OF INGOTS.

Ingot and Grade No.	Class of Ingot.
I—1	C
II—1	A—*a*
II—2	
II—3	
III—0	C
III—1	
IV—1	A—*a*
IV—1 (*a*)	A—*a*
IV—1 (*b*)	B—*a*
V—1	C
V—2	F
VI—1	B—*b*
VI—4	
VII—1	C
VII—2	
VII—3	
VIII—1	B—*b*
VIII—2	
VIII—3	
VIII—4	
IX—1	D
IX—2	
IX—3	
IX—4	
X—1	A—*a*
X—2	
X—3	
X—4	
XI—0	A—*a*
XI—1	
XI—2	
XI—4	
XII—1 (*a*)	E
XII—1 (*b*)	
XII—2	
XII—3	
XII—4	
XIII—3	F
XIV—1	B—*b*
XIV—3	
XV—1	A—*b*
XV—2	
XV—3	
XV—4	
XVI—1	C
XVI—2	
XVI—3	
XVI—4	
XVII—1	F
XVII—2	

The reproductions of the sulfur prints (Figs. 5 and 6, Plates III and IV) also show such holes; several of the sound ingots

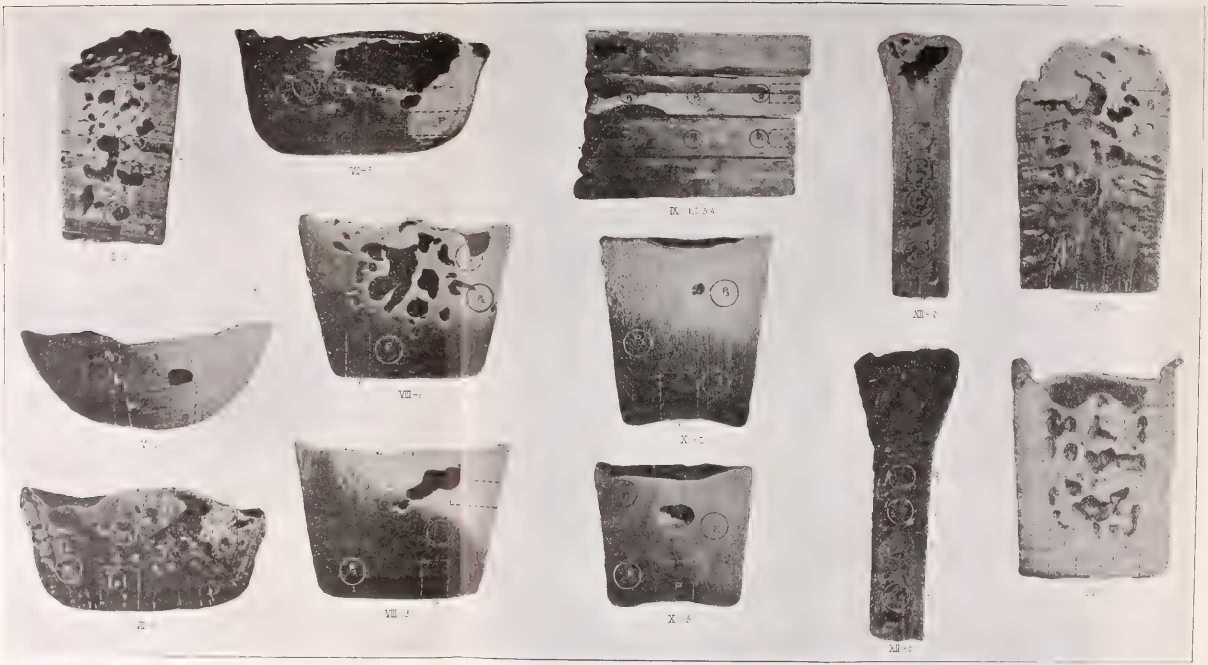


FIG. 2.—Samples of Split Ingots. P_1–P_3 indicate the Location of Drill Holes for Chemical Samples upon other Ingots of these same Types; P is the Manufacturer's Position for Taking Drillings for Analysis.

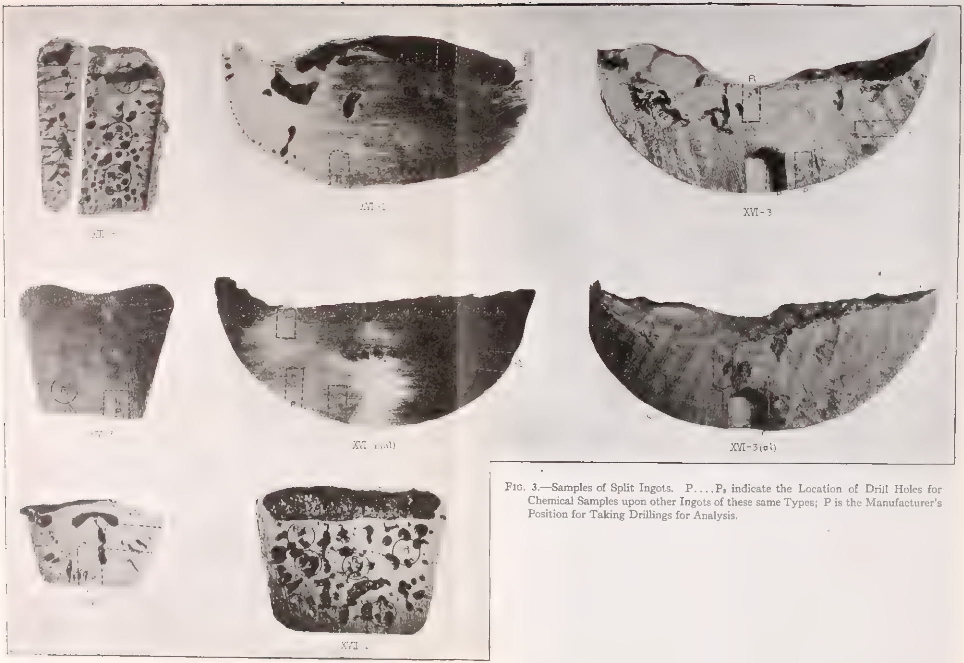


FIG. 3.—Samples of Split Ingots. P....P_5 indicate the Location of Drill Holes for Chemical Samples upon other Ingots of these same Types; P is the Manufacturer's Position for Taking Drillings for Analysis.

(Nos. V, IX, and X) which are not given in Table II are here shown.

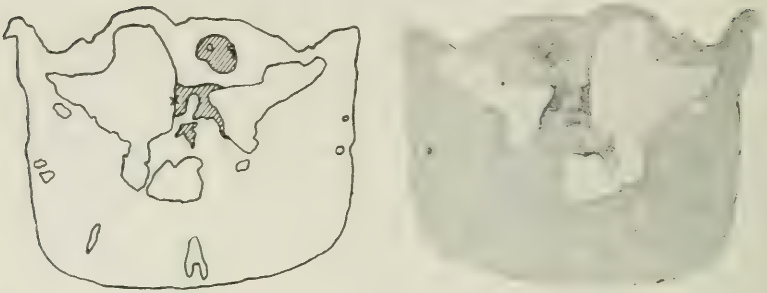
Segregation as Shown by Sulfur Prints.—The sulfur usually occurs in steel in the form of inclusions of manganese sulfide. By the use of photographic paper which has been soaked in dilute acid, the distribution of these sulfide specks in any section of the ingot can be recorded on the paper by the action of the hydrogen sulfide set free by the acid when the paper is pressed against the polished section. All of the metalloids in the steel segregate under similar conditions though not necessarily to the same extent, so that the sulfur print may be taken as an index of the distribution of the other important elements of the steel. It should however be borne in mind that the sulfur print is only a "segregation map" and that all "quantitative" results are only estimates based on the differences of tint in different portions of the print. Fig. 4 illustrates how one element (sulfur)

TABLE II.—RESULTS OF EXAMINATION OF SECTIONS OF SELECTED INGOTS.

Ingot and Grade No.	Class of Ingot.	Number of Blowholes.			Remarks.
		Oxidized.	Unoxidized.	Total.	
II—1	A—a	13	1	14	.....
II—3	A—a	10	5	15	Mostly small skin blowholes.
III—1	C	6	5	11	Large central holes.
IV—1	A	0	1	1	½-in. central hole.
VI—1	B—b	0	2	2	Small.
VI—4	B—b	21	30	51	Most are near edge.
VII—2	C	4	0	4	One very large one, near top.
VII—3	C	5	0	5	Large, near top of ingot.
VIII—1	B—b	0	6	6	Small, central.
VIII—4	B—b	59	14	73	Mostly small skin blowholes.
XI—1	A—a	0	19	19	Deep seated.
XI—3	A—a	5	3	8	Deep seated.
XII—1	E	5	2	7	Deep seated.
XII—3	E	7	2	9	Deep seated.
XIII—3	F	13	1	14	Some large, scattered
XIV—1	B—b	0	7	7	Small.
XVII—1	F	1	16	17	Small.

Number in which most of the holes are oxidized (at least two-thirds of total number)	8
Number in which most of the holes are unoxidized (at least two-thirds of total number)	6
Number in which oxidized and unoxidized are fairly equally divided	3

Under heading "oxidized blowholes" are included those cavities which showed any trace of color whatever, so that the showing is worse than it really was observed to be. The number of holes containing a thick coating of scale was considerably less than the totals given above.

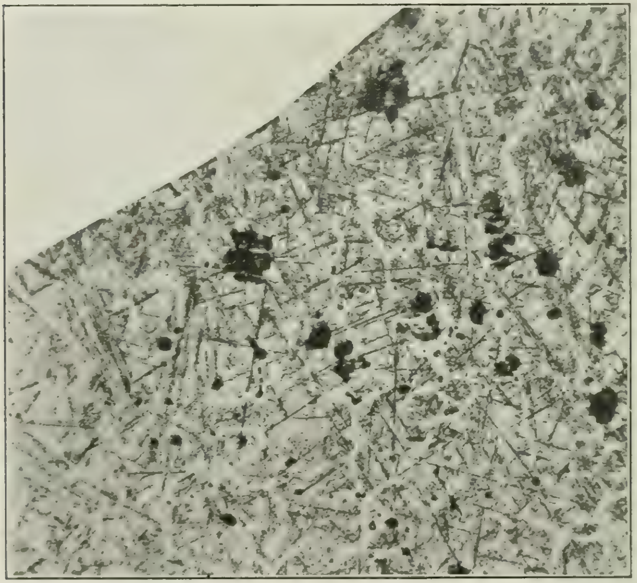


(*a*)

Section of split ingot showing gas cavities and carbon-segregated areas (shaded), as revealed by dilute nitric-acid etching.

(*b*)

Sulfur print of section shown in (*a*).



(*c*)

Photomicrograph of spot × in (*a*). The dark needles are free cementite, indicating a carbon content considerably above the eutectoid ratio (0.85).

FIG. 4.—Illustration of Simultaneous Segregation of Carbon and Sulfur (Ingot No. VII-3).

follows another (carbon) in its segregation. The outline sketch of the section of ingot No. VII-3 shows the number and distribution of the blowholes; the several areas which etched rather dark in acid (2 per cent HNO_3) are shaded. A microscopic examination shows that these spots are areas of high carbon content as illustrated in the photomicrograph of one of these areas. The sulfur prints of these same sections show similar dark areas, thus indicating higher sulfur content, exactly coinciding with the high carbon areas.

The segregation of sulfur is probably a mechanical process while that of carbon, phosphorus, etc., is more strictly chemical. The process of freezing of steel is a selective one; those portions solidifying first are lowest in carbon and other constituents which are dissolved in the iron at high temperatures. Sulfur exists as manganese sulfide which, so far as known, is not soluble in the iron at ordinary temperatures. Many of the tiny globules become entangled between the growing crystals but also many are pushed ahead by the advancing crystals into the melt which is the last to solidify, that is, the portion highest in carbon. In eleven of the sets examined, the metal shows evidence of having cooled rather slowly, the outer layer sometimes ½ in. thick, in which the crystals are long and "grow" perpendicularly to the surface, shows a sulfur content considerably less than the interior. The appearance bears out the suggestion made that the sulfides are pushed ahead by the growing crystals toward the still liquid center (see Fig. 5, Ingot No. VIII-4).

Microscopic Examination.—A microscopic survey of sections of selected ingots was made with the purpose of determining: (1) the amount of surface decarburization; (2) the nature of the metal bounding the blowholes and gas cavities; and (3) the location of areas of pronounced segregation of carbon. The specimens used were cross-sections of the ingots at one-third the height from the base except that in the case of low, flat forms a medial vertical section was used. The results are given in Table III.

The amount of surface decarburization, such as can be determined by the microscope, of the metal surrounding the holes is slight and almost negligible except in one case (ingot No. XIII). The depth of surface decarburization is also very much less than is usually allowed in drilling samples. The metal surrounding the blowholes, with the exception of the decarburization noted above, showed no abnormalities.

TABLE III.—MICROSCOPIC SURVEY OF SECTIONS OF SELECTED INGOTS.

Ingot and Grade No.	Class of Ingot.	Carbon, per cent.	Number of Blowholes.		Surface Decarburization.	Decarburization around Blowholes.	General.
			Oxidized.	Unoxidized.			
II—1.....	A—a	0.16	13	1	None observed.	None.	......
II—3....	A—a	0.71	10	5	0.3 mm.	None observed except in skin blowholes, same as exterior.	Some small cementitic areas seen in central part.
III—0....	C	0.015	6	5	Carbon content of ingot too low to show.	......	A few small central spots, C=0.06–0.08 per cent.
IV—1.....	A—a	0.18	0	1	0.3 mm.; partial decarburization to 0.6 mm.	None.	Large central blowhole.
VI—1.....	B—b	0.19	0	2	None.	None.	Very uniform across section.
VI—4.....	B—b	0.97	21	30	Layer 0.1 mm. partially decarburized.	None.	......
VII—2....	C	0.36	4	0	Complete decarburization, 0.25 mm. Gradual decarburization, 0.75 mm.	None.	......
VII—3....	C	0.66	5	0	Gradual decarburization, 0.4 mm.	Only a slight amount (0.4 per cent C.) in few cases.	Two cementitic areas $\frac{1}{20}$ by $\frac{1}{4}$ in. near center.
VIII—1...	B—b	0.21	0	6	None.	None.	......
VIII—4...	B—b	1.00	59	14	None.	None.	......
XI—0....	A—a	0.03	0	19	Carbon content too low to show any decarburization.	......	Very uniform in structure across section.
XI—2.....	A—a	0.37	5	3	0.5 mm.	None.	......
XII—1....	E	0.08	5	2	None.	None.	......
XII—3....	E	0.63	7	2	0.6 mm., gradual decarburization to 1.3 mm.	Some holes, gradual decarburization to 0.18 mm. Others none.	......
XIII......	F	0.68	13	1	0.4 mm., gradual decarburization to 1.7 mm.	Same as exterior.	Badly oxidized and decarburized.
XIV—1...	B—b	0.15	0	7	None.	None.	......
XVII-2...	F	0.21	1	16	None.	None.	Found two $\frac{1}{4}$-in. spots; 0.6 per cent of carbon near center of section.

Unless the areas of segregation show a decided difference of carbon content compared with the surrounding metal, it is

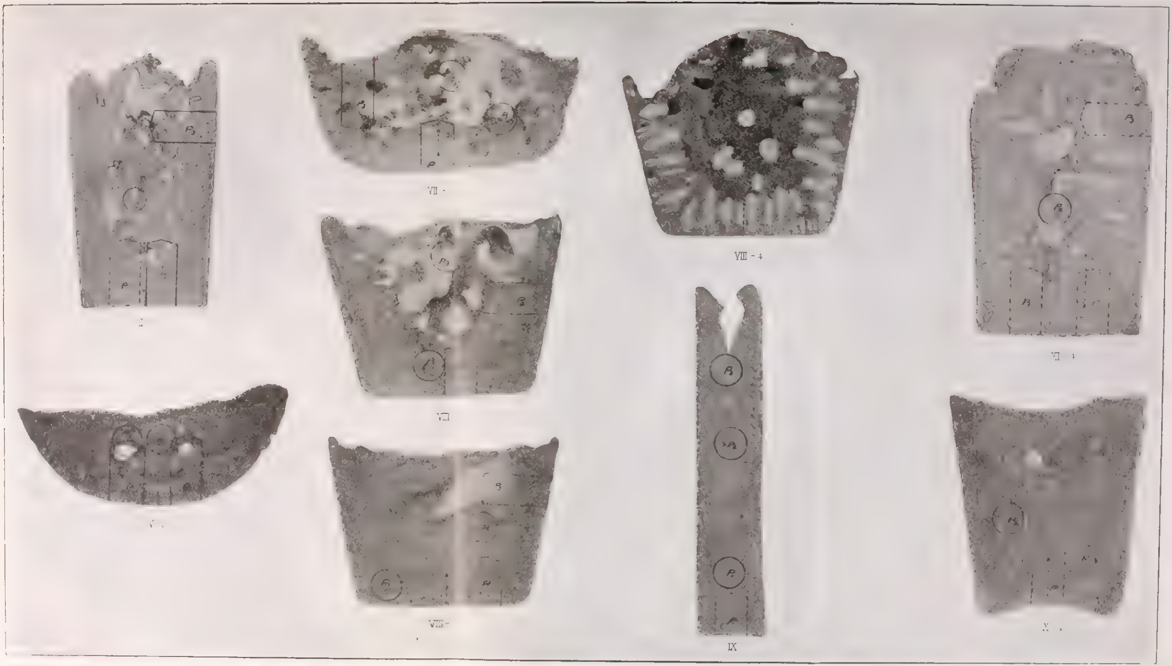


FIG. 5.—Typical Sulfur Prints of Split Ingots. Compare Figs. 2 and 3 for the Location of Samples Used for Chemical Analysis.

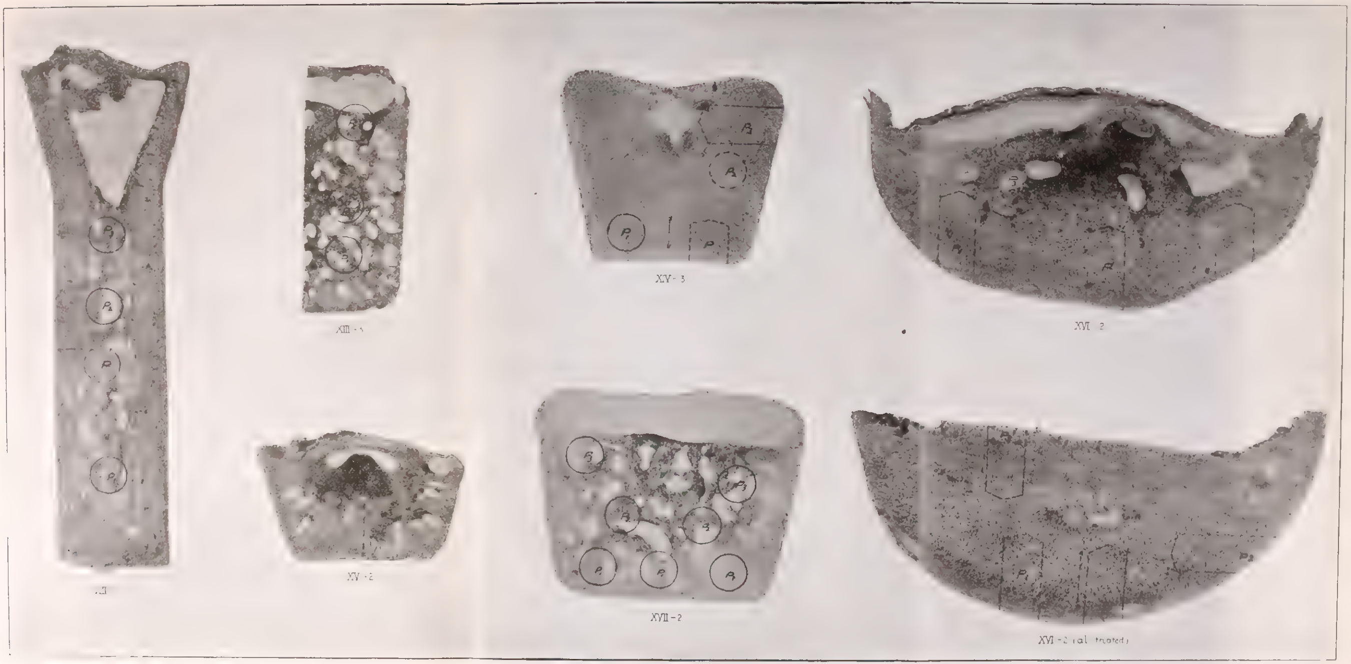


FIG. 6.—Typical Sulfur Prints of Split Ingots.

practically impossible to map with certainty such areas in cast steel which is so coarsely crystallin as are these samples. Fig. 4 already referred to shows that spots of very high carbon content are formed and that they are associated with a similar high sulfur content. It will be noted that the analytical results in Table IV show considerable variation in carbon in some cases; it is believed that carbon differences of this order cannot at present be detected by the microscope under the conditions imposed by this investigation.

CHEMICAL STUDY.

Selection of Ingot Types for Examination.—In selecting ingot types for the chemical study of homogeneity it was decided to limit the examination to grades Nos. 2 and 3 (approximately 0.4 and 0.7 per cent of carbon), inasmuch as these were more fully represented among the various types submitted than were the very high and very low-carbon grades. The survey was limited to the elements carbon, sulfur, and phosphorus, these being most liable to segregation and of greatest importance in determining the quality of steel.

Location of Drill Holes and Method of Taking Drillings.—In deciding upon a plan for a systematic scheme of drilling these small ingots at certain predetermined places, as is usual in ingot surveys, a number of difficulties at once presented themselves. It was found that the geometrical shape in some cases prevented the drill holes from always being located in the same relative position; sometimes, where the position of a drill hole had been planned beforehand it would be found that this position was in a region so full of blowholes that no drillings could be taken, or else there was so much scale present (especially in top positions) that the location of a drill hole at this point was out of the question. It seemed desirable to limit the size of the drill hole to the minimum diameter consistent with securing enough drillings for analysis, but this requirement was a difficult one because of the very general physical unsoundness of the ingots. It had been thought, in originally planning this investigation, that the microscopic indications would be a guide to proper places to drill, but even if non-homogeneity had been thus

TABLE IV.—BUREAU OF STANDARDS ANALYSES OF LADLE TEST INGOTS.[1]

Ingot and Grade No.	Class of Ingot.	Location of Drill Hole.	Weight of Drilling, g.	Carbon, per cent.			Maximum Difference Segregation of Carbon.	Sulfur, per cent.		Segregation of Sulfur.	Phosphorus, per cent.		Segregation of Phosphorus.	Indications of Sulfur Prints.[2]
				P	P_1	P_3		P_1	P_3		P_1	P_3		
II—2	A—*a*	P_1	18.465	0.370	0.366	0.412	.....	0.020	0.030	0.010	0.025	0.028	0.003	$P_3 > P_1$.
		P_3	23.378	.....	0.348	0.396	0.048	.....	.....	.....	.....	.....	.....	
V—2	C	P_1	15.296	0.394	0.367	0.353	0.041	0.045	0.041	0.004	0.029	0.027	.....	Uniform print.
		P_3	24.544	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
VII—2	C	P_1	23.036	0.373	0.366	0.378	.....	0.024	0.024	.....	0.014	0.017	0.003	Uniform print.
		P_3	25.550	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
VII—3	C	P_1	17.93	0.703	0.706	0.713	.....	0.031	0.038	0.007	0.023	0.023	.....	$P_3 > P_1$.
		P_3	19.38	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
VIII—2	B—*b*	P_1	25.495	0.379	0.358	0.383	0.025	0.025	0.027	.....	0.030	0.026	0.004	$P_3 > P_1$.
		P_3	20.160	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
VIII—3	B—*b*	P_1	32.17	0.723	0.725	0.725	.....	0.030	0.029	.....	0.017	0.017	.....	Uniform print.
		P_3	21.60	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
IX—2	D	P_1	27.119	0.425	0.421	0.419	.....	0.025	0.023	.....	0.023	0.022	.....	Uniform print.
		P_3	25.581	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
IX—3	D	P_1	25.388	0.568	0.574	0.553	0.021	0.035	0.034	.....	0.020	0.018	.....	Uniform print.
		P_3	24.762	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
X—2	A—*a*	P_1	24.867	0.413	0.430	0.401	0.029	0.028	0.026	.....	0.017	0.016	.....	Uniform print.
		P_3	24.857	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
X—3	A—*a*	P_1	21.558	0.715	0.703	0.702	.....	0.027	0.024	.....	0.010	0.010	.....	Uniform print.
		P_3	21.147	.....	0.724	0.718	.....	.....	.....	.....	.....	.....	.....	
XI—2	A—*a*	P_1	16.514	0.336	0.336	0.375	0.039	0.010	0.012	.....	0.017	0.013	0.004	$P_3 = P_1$ (approx.).
		P_3	19.305	.....	0.338	0.375	.....	.....	.....	.....	.....	.....	.....	
XI—4	A—*a*	P_1	17.367	1.10	1.11	1.07	0.040	0.014	0.016	.....	0.010	0.011	.....	$P_3 = P_1$ (approx.).
		P_3	12.192	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

TABLE IV.—*Continued.*

Ingot and Grade No.	Class of Ingot.	Location of Drill Hole.	Weight of Drilling, g.	Carbon, per cent.			Maximum Difference Segregation of Carbon.	Sulfur, per cent.		Segregation of Sulfur.	Phosphorus, per cent.		Segregation of Phosphorus.	Indications o Sulfur Prints.[2]
				P	P_1	P_3		P_1	P_3		P_1	P_3		
XII—2	E	P_1	21.434	0.438	0.335	0.400	0.105	0.019	0.025	0.006	0.019	0.025	0.006	$P_3 > P_1$ (slight).
		P_3	21.306	.....	0.338	0.399	.....	.....	.....	.....	.....	.....	.....	
XII—3	E	P_1	16.57	0.617	0.636	0.635	.....	0.032	0.033	.....	0.014	0.014	.....	$P_3 = P_1$ (approx.).
		P_3	17.77	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
XIII—3	F	P_1	8.330	0.604	0.439	0.664	0.225	0.071	0.055	0.016	0.017	0.018	.....	$P_3 > P_1$.
		P_3	15.804	.....	.....	.....		.....	.....	.....	.....	.....	.....	
XIV—3	B—*b*	P_1	19.461	0.648	0.659	0.635	0.024	0.027	0.033	0.006	0.029	0.030	.....	$P_3 > P_1$ (slight).
		P_3	19.732	.....	.....	.....			.....	.....	.....	.....	.....	
XV—3	A—*b*	P_1	6.19	0.581	0.606	0.683	0.102	0.025	0.032	0.007	0.023	0.030	0.007	$P_3 > P_1$.
		P_3	13.63	.....	0.606	0.679	.....		.....	.....	.....	.....	.....	
XVI—2	C	P_1	25.100	0.402	0.421	0.444	0.042	0.033	0.039	0.006	0.023	0.026	0.003	$P_3 > P_1$.
		P_3	20.431	.....	.....	.....		.....	.....	.....	.....	.....	.....	
XVI—3	C	P_1	19.531	0.663	0.668	0.674	.....	0.038	0.038	.....	0.021	0.029	0.008	Uniform print.
		P_3	19.834	.....	.....	.....		.....	.....	.....	.....	.....	.....	
XVI[3]—2	C	P_1	21.123	.....	0.399	0.423	0.024	0.036	0.038	.....	0.025	0.025	.....	$P_3 = P_1$ (approx.).
		P_3	12.376	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
XVI[3]—3	C	P_1	19.973	0.675	0.660	0.683	0.023	0.034	0.034	.....	0.029	0.028	.....	Uniform print.
		P_3	21.568	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
XVII—2 ..	F	P_1	3.412	.....	0.423	0.456	0.033	0.028	0.024	0.004	0.010	0.009	.....	$P_3 > P_1$.
		P_3	6.373	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
XVII—2	F	P_1	15.17	0.449	0.445	0.450	.....	0.027	0.030	.....	0.005	0.009	0.004	$P_3 > P_1$.
		P_3	16.18	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	

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[1] We are indebted to Mr. S. M. Hull of the Bureau of Standards for a number of the determinations in this table.

[2] These indications are from other ingots of the same size, shape and grade, except ingot No. XV—3, which is compared with ingot No. XV—2 (Fig. 6).

[3] Aluminum was added to these test ingots.

indicated (which was not always the case), the presence of numerous blowholes at the places examined microscopically would probably have prevented the taking of drillings there. For this reason the metallographic study did not give the assistance in this regard which was expected of it. In view of all these facts the best that could be done in selecting places to drill the ingots for chemical study of segregation, was to drill at approximately four positions in the ingot, as indicated in Figs. 2 and 3. In some of the semi-spherical ingots no holes were put in through the scale of oxide on the surface, as this was so thick and irregular and so honeycombed with cavities that it would have been impossible to drill here. Instead, the holes were spaced on the under surface as nearly in accordance with the general scheme as possible. In drilling the small wedge-shaped ingots it was found necessary to put in two and sometimes

TABLE V.—ANALYSES OF MELTS FROM WHICH LADLE TEST INGOTS WERE POURED.

Ingot and Grade No.	Class of Ingot.	Phosphorus, per cent.	Sulfur, per cent.	Manganese, per cent.	Silicon, per cent.	Carbon, per cent.	Other Elements, per cent.
II—2	A—*a*	0.023	0.028	0.57	0.01	0.40	......
V—2	F	0.030	0.045	0.67	0.322	0.34	......
VII—2	C	0.022	0.023	0.52	0.052	0.36	......
VIII—2	B—*b*	0.033	0.035	0.45	0.018	0.37	......
VIII—3	B—*b*	0.018	0.036	0.75	0.184	0.74	......
IX—2	D	0.026	0.030	0.48	0.100	0.45	......
IX—3	D	0.037	0.034	0.40	0.006	0.60	......
X—2	A—*a*	0.017	0.036	0.687	0.295	0.435	Nickel....... 0.3 Chromium.... 0.16 Copper....... 0.22
X—3	A—*a*	0.012	0.035	0.714	0.145	0.690	Nickel....... 0.16 Chromium.... 0.16 Copper....... 0.11
XI—2	A—*a*	0.011	0.015	0.47	0.004	0.37	......
XII—2	E	0.027	0.028	0.50	0.007	0.42	......
XII—3	E	0.010	0.030	0.46	0.008	0.63	......
XIII—3	F	0.018	0.059	0.69	0.091	0.678	Chromium.... 0.19 Nickel........ 0.56
XIV—2	B—*b*	0.027	0.037	0.50	0.033	0.42	......
XIV—3	B—*b*	0.028	0.024	0.80	0.410	0.68	......
XV—3	A—*b*	0.034	0.038	0.73	0.40	0.62	......
XVII—2	F	0.011	0.023	0.70	0.040	0.45	......

three adjacent drill holes (see Fig. 3), because of the thin section after surface discard, in order to get a volume of metal equivalent to that usually represented by a drill hole. Thus, drillings from such ingots represent a larger area than in the case of other ingots, and this should tend to average differences in composition found in the single drill holes; in spite of this favorable consideration these ingots showed marked non-homogeneity in carbon content (see Table V).

It was thought that by using the same size drill and always carrying the drill hole to the same depth (or equivalent depth where the ingot thickness was less than the depth of drill hole), a means would be offered of measuring the ingot soundness at the place drilled. This was accomplished by carefully preserving all drillings (after surface discard) and weighing them. A flat V-shaped, $\frac{1}{2}$-in. drill was used, and by placing a stop on the shank it was arranged that all drill holes should be 1 in. deep. Allowing for irregularities in this somewhat rough adjustment, the weight of drillings to be expected from such a drill hole with sound metal would be 22 to 24 g. Marked shortage in this weight is then a direct measure of unsoundness. These weights are given in a column of Table IV, and it is seen by this criterion that of 46 places drilled (excluding the manufacturers' drill holes where weight of drillings was not taken, owing to lack of uniformity of their practice as to size and depth of drill hole) 25, or over 54 per cent, were unsound.

Character of Drillings Obtained.—The drillings obtained presented much variation in physical character, ranging from dust, through long thin chips to curled-up masses, and were frequently full of visible scale and large pieces representing walls of blowholes broken off by the drill. The sharpness and angle of the drill, the pressure on same, and its speed were kept as nearly constant throughout as was possible, so that these differences in physical character of drillings were due solely to the nature of the metal at the places drilled. As will be seen later, some of these drillings presented difficulties from the analytical chemical standpoint.

Methods Used for Chemical Analysis.—For determination of carbon, the barium-carbonate-titration method was used; for sulfur, the evolution method with theoretical standard for iodine solution; and for phosphorus, the alkalimetric method with theoretical standard for the volumetric solutions. By employing the theoretical standard for the volumetric solutions used in the phosphorus and sulfur determinations, there was eliminated all question as to similarity between standard steel and the steels worked upon, in case a standard steel had been used for standardizing these solutions, and the results for all ingots are therefore strictly comparable. In comparing our own results with those reported by manufacturers as representing the ladle analyses of the melts from which the ingots were made, we find some differences, as will be seen by a comparison of Tables IV and V. Of course, these are to be expected, because the manufacturer frequently takes drillings from several ladle ingots poured from different parts of the melt and analyzes the mixed drillings. Differences are to be expected, also, because of the chemical and physical non-homogeneity of the ingots themselves, as shown by our results, making it improbable that the results from the manufacturer's ingot, where only one was analyzed by him, should agree with ours. There is also room for a difference because of the methods used by us for standardizing volumetric solutions as compared with the practice of manufacturers, where an empirical rather than the theoretical standard is often used.

DISCUSSION OF ANALYTICAL RESULTS.

An inspection of Table IV shows that, of those examined, fifteen ingots (over 65 per cent) were non-homogeneous[1] as to carbon, nine (over 39 per cent) as to sulfur, and nine (over 39 per cent) as to phosphorus. The sulphur and carbon appear to behave somewhat similarly in that a sulfur difference is usually accompanied by a carbon difference, but not always vice versa. The phosphorus differences are not so great as the others and do not connect themselves up closely with the sulfur and carbon results. It will be noted on referring to the last column of Table IV that there is a general parallelism between the indications of the sulfur prints and the analytical results; in interpreting this it should be borne in mind that the sulfur prints were not taken on the ingots drilled but upon a companion set.

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[1] The following differences are regarded by us as non-homogeneous: Carbon, more than 0.02 per cent; phosporus and sulfur, more than 0.003 per cent.

It is believed that there is a tendency for deoxidation in the regions surrounding blowholes, whose walls are covered with oxide scale, and the effect of this would be to reduce the carbon content of the metal in such areas; there may also be an effect in apparently reducing the sulfur content, since the ferric chloride formed from the scale contained in the drillings, when dissolving these for the evolution sulfur determination, would tend to oxidize the evolved hydrogen sulfide, thus giving low results by this method.

DISADVANTAGES OF TEST INGOTS CONTAINING BLOWHOLES.

Further practical disadvantages of such ingots have already been indicated, namely, the inconveniences in drilling them and the possible analytical errors resulting from the character of drillings obtained. The latter may be classed as: (1) difficulty of burning large pieces chipped from walls of blowholes when determining carbon by direct combustion of the drillings, and possible error from this cause—in the present work special precautions were taken in this regard; (2) the possible effect of oxide scale on the evolution-sulfur determination mentioned above; (3) the effect of scale on the phosphorus determination—the scale is insoluble in the dilute nitric acid used in preparing the steel for phosphorus determination and correction would have to be made for it; if the molybdate reduction method were used it would have to be filtered off, a time-consuming operation; and (4) the scale is relatively insoluble and present in large flakes, hence probably would introduce an error into rapid silicon determinations unless correction were made by volatilizing, thereby prolonging the time needed for this determination.

PLANS FOR FURTHER WORK.

Evidence of some segregation in sulfur and carbon is shown by some of all of the different shapes used. No one shape or size can be said to be the worst in this respect. The apparent variations in the rate of freezing of the different forms make it difficult to attribute any segregation observed to any one cause.

The future contemplated work on this subject will aim to secure sound ingots of the shapes and sizes already examined. This is believed to be a necessary preliminary to the work of deciding upon the best shapes and sizes, if there are such, and accordingly the following program for further work has been developed:

1. Extension of the metallographic study to several planes through the ingot, with provision, if possible, for a closer estimation of sulfur and carbon differences metallographically.

2. Pouring of selected test ingot types at one time and place from two grades of steel—a low-carbon type (grade No. 1) and a medium-carbon type (grade No. 3), each type having composition and metallurgical treatment to give (*a*) "rising" steel (not completely freed from gases) and (*b*) "quiet" steel, such as would give sound test ingots; the ingots poured as in (*a*) to be given aluminum treatment to make them sound. Examination of these ingots in a manner similar to the present investigation.

3. Following completion of this part of the investigation, a similar study should be made of selected ingot types poured in molds having the same mass, in such way as to secure uniform chilling effect.

4. Finally, the question of relation of test ingot analyses to composition of rolled products should be undertaken.

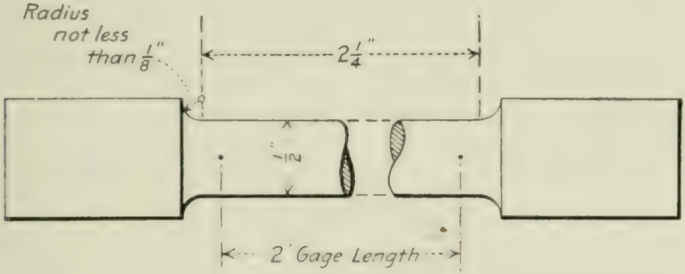
ADDENDUM

TO

REPORT OF COMMITTEE A-1.

At the regular meeting of Committee A-1 held at Atlantic City on Monday evening, June 26, 1916, which was attended by 40 members, the following amendments to the annual report of the committee were unanimously approved:

1. The committee recommends that the Standard Specifications for Quenched Carbon-Steel Track Bolts (Serial Designation: A 50–15) and the Standard Specifications for Quenched Alloy-Steel Track Bolts (Serial Designation: A 51–15) be revised by the addition of the following sentence to Section 11 in each specification:



Note:- The Gage Length, Parallel Portions and Fillets shall be as Shown, but the Ends may be of any Form which will Fit the Holders of the Testing Machine.

> "The length of the bolt under the head shall not vary more than $\frac{1}{8}$ in. from that specified."

2. The committee recommends that the Standard Specifications for Automobile Carbon and Alloy Steels (Serial Designation: A 29–15) be revised by changing Section 10 on "Elastic Limit" as recommended for Section 10 (*d*) of the Standard Specifications for Carbon-Steel and Alloy-Steel Forgings, page 114.

3. The committee recommends that its proposed revisions of the standard 2-in. tension tests specimens as given on pages 106–108 be amended a follows:

(*a*) Change the paragraph at the top of page 107 to read:

> "Tension test specimens shall conform to the dimensions shown in Fig. 2. The ends shall be of a form to fit the holders of the testing machine in such a way that the load shall be axial."

(*b*) Change Fig. 2 on page 107 to the form shown in this Addendum (page 145).

EDITORIAL NOTE.

The proposed revisions of the Standards referred to in the report as Nos. 1–17, pages 87–88, as well as those referred to in the Addendum, were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916. The Standards as thus revised appear in the 1916 Volume of A.S.T.M. Standards.

The seven proposed Standards referred to in this report as Nos. 18–24, pages 88–89, were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appear in the 1916 Volume of A.S T.M. Standards.

The six proposed Tentative Standards referred to in the report as Nos. 25–30, pages 90–91, were accepted for publication, and appear on pages 410–433.

The miscellaneous recommendations given on pages 91 and 105–109, as amended in the Addendum to the report, were approved at the meeting.

REPORT OF COMMITTEE A-2

ON

WROUGHT IRON.

The work of this committee during the past year, with the exception of an extensive series of tension and vibratory tests of staybolt iron conducted by Sub-Committee III, has been confined to work by Sub-Committee I on Tubes and Pipe. This sub-committee, working in conjunction with Sub-Committee IX of Committee A-1 on Steel Tubing and Pipe as a joint committee, agreed upon certain changes in the Table of Standard Minimum Weights in the Standard Specifications for Lap-Welded Iron Boiler Tubes (Serial Designation: A 38–12).[1]

In the following table the present values are in Roman numerals, and the recommended change consists in substituting for the values in parentheses the corresponding italicized values.

Standard Minimum Weights.

Thickness.		Weight, lb. per ft. of Length. Outside Diameter, in.			
In.	Nearest B. w. g.	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$
0.095	13	1.65	(1.91) *1.90*	(2.16) *2.14*	....
0.110	12	1.89	(2.17) *2.18*	2.46	(2.73) *2.75*
0.125	11	(2.07) *2.13*	(2.38) *2.45*	(2.70) *2.78*	(3.02) *3.11*
0.135	10	(2.29) *2.28*	2.64	2.99	(3.37) *3.34*

The present table is incorrect in that the different thicknesses, as expressed in decimals of an inch, do not conform exactly to the respective B. w. g. numbers included in the table, but to the B. w. g. number corresponding closest to that particular thickness. The revised table harmonizes with the table included in the Standard Specifications for Steel Tubes,[2] but the weights of the tubes are 2 per cent less than the weights of the steel tubes for the corresponding diameters and gages.

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[1] 1915 Year-Book, p. 264.

[2] *Ibid.*, p. 162.

Committee A-2 recommends that this proposed revision be referred this year to letter ballot of the Society for adoption.

At a subsequent meeting of the joint committees referred to above, the following recommendations were made:

1. That the title of the present Standard Specifications for Lap-Welded Iron Boiler Tubes be changed to read: "Lap-welded Charcoal-Iron Boiler Tubes, Boiler Flues, Safe Ends and Arch Tubes for Locomotives:" and

2. That the table of Standard Minimum Weights be extended to include the sizes and gages ordinarily used in locomotive practice.

Although the chairman of Sub-Committee I called two different meetings of that sub-committee for the purpose of voting upon this recommendation, no action could be taken owing to the meager attendance at each meeting. In view of this condition and the importance of including these changes in this year's revision of the specifications, Committee A-2 begs to report that these points will be considered at a meeting of the whole committee to be held just prior to the annual meeting, and that its recommendations in this respect will be presented upon the floor of the meeting in connection with the presentation of this printed report.

This report has been referred to letter ballot of Committee A-2, which consists of 36 members, of whom 28 have voted affirmatively, none negatively, and 8 have refrained from voting.

Respectfully submitted on behalf of the committee,

S. V. HUNNINGS,
Chairman.

J. B. YOUNG,
Secretary.

EDITORIAL NOTE.

In presenting this report at the annual meeting, Committee A-2, in pursuance of the purpose announced in the closing paragraph of the report, recommended that the two proposed revisions Nos. 1 and 2 (page 148) also be referred to letter ballot of the Society for adoption. The effect of the second recommendation, relative to the table of Standard Minimum Weights, is to replace the present table by the following:

STANDARD MINIMUM WEIGHTS.

THICKNESS.		WEIGHT, LB. PER FT. OF Length. Outside Diameter, in.												
In.	Nearest B. w. g.	$1\frac{3}{4}$	2	$2\frac{1}{4}$	$2\frac{1}{2}$	3	$3\frac{1}{2}$	4	$4\frac{1}{2}$	5	$5\frac{1}{4}$	$5\frac{3}{8}$	$5\frac{1}{2}$	6
0.095	13	1.65	1.90	2.14	2.39	....	....	....	....	....	....	....	....	....
0.110	12	1.89	2.18	2.46	2.75	3.33	....	....	....	....	....	....	....	....
0.125	11	2.13	2.45	2.78	3.11	3.76	4.42	....	....	....	....	....	....	....
0.135	10	2.28	2.64	2.99	3.34	4.05	4.76	5.46	....	....	....	....	....	....
0.150	9	2.51	2.90	3.29	3.68	4.48	5.26	6.05	6.83	7.61	8.01	8.20	8.40	9.18
0.165	8	....	....	....	4.03	4.90	5.76	6.62	7.49	8.35	8.78	9.00	9.21	10.07
0.180	7	....	....	....	4.37	5.31	6.25	7.19	8.13	9.08	9.55	9.79	10.03	10.97

These recommended revisions were approved and subsequently adopted by letter ballot of the Society on September 1, 1916. The Standard as thus revised appears in the 1916 Volume of A.S.T.M. Standards.

REPORT OF COMMITTEE A-3

ON

CAST IRON AND FINISHED CASTINGS.

The following matters have engaged the attention of Committee A-3 during the past year:

Sub-Committee IV on Car Wheels has been busy on a revision of the Standard Specifications for Cast-Iron Car Wheels (Serial Designation: A 46–05)[1] and has held two meetings. This work has not yet been completed and will be continued during the coming year.

For several years there has been a general demand for specifications for cast-iron soil pipe and fittings. Manufacturers and consumers alike have come to realize that there are too many minor variations in what should be just as much subject to standardization as the material for water distribution systems. A great stride in this direction has already been made by organizations of manufacturers and sanitary engineers, but the results have not as yet been entirely satisfactory. Committee A-3, therefore, took up the subject and an attempt was made to form a sub-committee on the matter at issue.

It is interesting to note that while the question of soil pipe is becoming more and more acute from sanitary and structural considerations, in view of the enormous structures going up in large business centers, it has been found impossible to organize a sub-committee on the subject to conform with the Regulations Governing Standing Committees. Great interest was manifested on all sides, but no active cooperation was volunteered by the consuming interests. Committee A-3, therefore, placed the question of drawing up tentative specifications for cast-iron soil pipe and fittings in the hands of those representatives of the manufacturing and consuming interests within the committee qualified to act in the matter, and tentative specifications were duly worked out. They have been circulated among those competent to pass upon them, with the usual result of little help but much criticism. The matter will therefore be brought to the attention of the committee as a whole, for further action.

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[1] 1915 Year-Book p. 303.

Committee A-3 hereby recommends that the Tentative Methods for Sampling and Analysis of Pig and Cast Iron, published in the 1915 Year-Book among the Tentative Standards,[1] be referred to letter ballot of the Society for adoption as standard.

This report has been submitted to letter ballot of the committee, which consists of 41 members, of whom 31 have voted affirmatively, none negatively, and 10 have refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

G. C. DAVIES,
Secretary.

EDITORIAL NOTE.

The proposed Standard referred to in this report was approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appears in the 1916 Volume of A.S.T.M. Standards.

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[1] 1915 Year-Book, p. 519.

REPORT OF COMMITTEE A-4

ON

HEAT TREATMENT OF IRON AND STEEL.

Committee A-4 has no report to make this year involving recommended practice for heat treatment, or any changes to suggest in the recommended practice embodied in previous reports of the committee.

The committee, however, desires to call the attention of the Society to the work which it feels it ought to do in consultation with the other committees. Committee A-4 is made up of experts in heat treatment and it feels that when other committees are considering questions involving heat treatment, especially if these questions are to be made part of the subject matter of specifications, such committees should submit these points to Committee A-4 for its comments and recommendations. The committee believes that this kind of cooperation should be its chief function.

This report has been submitted to letter ballot of the committee, which consists of 12 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

ALBERT SAUVEUR,
Chairman.

REPORT OF COMMITTEE A-5

ON

CORROSION OF IRON AND STEEL.

Committee A-5 submitted to the Society last year[1] a report giving the outline of a corrosion test which it proposed to make, and the present report can only be considered as one of progress.

The outline covered a great quantity of work, greater probably than the Society realized, in the collection, inspection and analysis of sheets; erection of sheds; and final exposure of the samples, and also in obtaining the funds necessary for carrying on the work.

The sheets of metal have been furnished and inspected. All of Series A (the open market products) and part of Series B (the special products) have been analyzed.

From the tabulation of chemical analysis of Series A, which are appended to this report, it will be noted that apart from some variations in the results obtained by the different laboratories on the same type of metal—which will be checked later—the composition is not entirely in accord with the specifications given in last year's report.

It was, however, decided at a meeting of the Advisory Committee that all of the sheets which had been secured and analyzed should be exposed and additional sheets be obtained of the No. 16 gage copper-bearing pure iron to contain the content of copper specified and that another lot of open-hearth steel be obtained of the specified low copper content, as the first lot contained a high percentage of copper.

It is interesting to note that the puddled irons have a high copper content, probably due to the use of Eastern Pennsylvania ores, and an effort will be made to secure a genuine puddled iron substantially free from copper.

Another interesting point is brought out by these analyses, namely, the low percentage of carbon of most of these sheets. It has been suggested that annealing and hot working reduces the percentage of carbon in the edges of the plates and it is expected that some work will be done to determine this point.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 130 (1915).

These analyses cover nearly one hundred sheets of eight types of metal bought in the open market, and furnish valuable information which will be available for other purposes.

The committee has enlarged its field of endeavor by the appointment of a sub-committee to investigate "Preservative Metallic Coatings for Metals." This sub-committee is primarily charged to study galvanized coatings and is now in process of organization.

It is desired to correct an error in the report presented last year, as follows: Strike out the third and fourth paragraphs[1] and insert two paragraphs reading as follows:

> "It was agreed that some of the sheets of the regular Bessemer, acid open-hearth and basic open-hearth steels should contain not over 0.02 per cent copper. The copper-bearing metals in this series will be of the same composition as above, except that the percentage of copper will be from 0.15 to 0.30.
>
> "The sheets for Series B will be supplied by a limited number of manufacturers."

This report has been submitted to letter ballot of the committee, which consists of 29 members, of whom 26 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

S. S. VOORHEES,
Chairman.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 130 (1915).

APPENDIX.

ANALYSIS OF STEEL SHEETS, SERIES "A,"
FOR
CORROSION TESTS.

TABLE I.—NO. 22 GAGE BESSEMER STEEL.
SERIES A. MARKED *A*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.037	0.37	0.088	0.031	....	0.035	....
2	0.034	0.37	0.091	0.035	....	0.040	....
3	0.036	0.37	0.089	0.036	....	0.035	....
4	0.035	0.37	0.086	0.033	....	0.040	....
5	0.035	0.37	0.087	0.036	0.007	0.024	....
6	0.034	0.37	0.082	0.032	....	0.030	....
7	0.035	0.37	0.082	0.032	....	0.037	....
8	0.035	0.38	0.085	0.035	....	0.035	....
9	0.034	0.37	0.085	0.032	....	0.037	....
10	0.034	0.38	0.086	0.035	....	0.038	....
11	0.04	0.41	0.060	0.042	....	0.010	....
12	0.03	0.39	0.129	0.041	0.006	0.011	....
13	0.04	0.40	0.058	0.040	....	0.011	....
14	0.04	0.39	0.128	0.045	....	0.009	....
15	0.04	0.39	0.041	0.040	....	0.010	....
16	0.04	0.40	0.096	0.040	....	0.011	....
17	0.04	0.41	0.043	0.040	....	0.011	....
18 (std)	0.044	0.41	0.103	0.040	....	0.012	....
19	0.04	0.41	0.054	0.041	....	0.012	....
20	0.04	0.40	0.101	0.041	....	0.010	....
21	0.05	0.39	0.096	0.042	trace	0.020	0.01
22	0.05	0.40	0.093	0.036	trace	0.020	....
23	0.02	0.42	0.093	0.037	trace	0.020	....
24	0.04	0.39	0.091	0.037	trace	0.030	....
25	0.04	0.41	0.093	0.039	trace	0.020	....
26	0.05	0.40	0.130	0.062	....	0.020	....
27	0.05	0.40	0 121	0.055	....	0.020	....
28	0.05	0.38	0.102	0.048	....	0.020	....
29	0.03	0.39	0.090	0.036	....	0.020	....
30	0.04	0.40	0.087	0.036	....	0.020	....
31	0.04	0.35	0.078	0.036	....	0.006	....
32	0.04	0.36	0.105	0.046	....	0.008	....
33	0.04	0.36	0.086	0.035	....	0.008	....
34	0.04	0.38	0.084	0.039	....	0.008	....
35	0.04	0.36	0.090	0.036	0.012	0.006	0.002
36	0.03	0.37	0.093	0.042	....	0.008	....
37	0 04	0.40	0.087	0.035	....	0.008	....
38	0.02	0.37	0.091	0.040	....	0.014	....
39	0.03	0.37	0.094	0.037	....	0.006	....
40	0.04	0.39	0.092	0.039	0.014	0.006	0.003
41	0.047	0.41	0 088	0.041	0.005	0.012	....
42	0.040	0.41	0.089	0.041	0.004	0.014	....
43	0.036	0.38	0.095	0.047	0.005	0.014	....
44	0.037	0.36	0.090	0.040	0.004	0.016	....
45	0 026	0.38	0.094	0.044	0.005	0.014	....
46	0.041	0.41	0.082	0.040	0.004	0.014	....
47	0.034	0.39	0.083	0.041	0.005	0.010	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 11 to 20, inclusive.

TABLE II.—NO. 16 GAGE BESSEMER STEEL.
SERIES A. MARKED *AA*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1 (std)	0.054	0.45	0.093	0.038	....	0.010	....
2	0.060	0.44	0.046	0.044	....	0.011	....
3	0.040	0.43	0.097	0.045	....	0.009	....
4	0.04	0.42	0.073	0.042	0.003	0.010	....
5	0.06	0.45	0.054	0.049	....	0.010	....
6	0.05	0.42	0.087	0.046	....	0.009	....
7	0.04	0.42	0.064	0.046	....	0.009	....
8	0.05	0.45	0.040	0.045	....	0.010	....
9	0.05	0.45	0.043	0.044	....	0.011	....
10	0.05	0.45	0.093	0.043	....	0.010	....
11	0.05	0.45	0.073	0.045	....	0.009	....
12	0.05	0.45	0.043	0.044	....	0.009	....
13	0.014	0.42	0.087	0.041	0.004	0.012	....
14	0.020	0.41	0.086	0.044	0.002	0.014	....
15	0.036	0.43	0.085	0.040	0.004	0.012	....
16	0.015	0.41	0.092	0.041	0.002	0.014	....
17	0.018	0.48	0.090	0.041	0.004	0.014	....
18	0.023	0.42	0.090	0.041	0.002	0.010	....
19	0.018	0.36	0.081	0.040	0.004	0.012	....
20	0.018	0.41	0.084	0.041	0.004	0.012	....
21	0.018	0.40	0.085	0.043	0.004	0 010	....
22	0.022	0.42	0.085	0.041	0.002	0.010	....
23	0.034	0.42	0.084	0.041	0.004	0.010	....
24	0.018	0.41	0.086	0.041	0.002	0.010	....
25	0.032	0.40	0.087	0.039	....	0.019	....
26	0.032	0.40	0.083	0.037	....	0.018	....
27	0.032	0.39	0.085	0.041	....	0.018	....
28	0.035	0.40	0.080	0.039	....	0.018	....
29	0.035	0.40	0.086	0.040	....	0.016	....
30	0.035	0.39	0.082	0.040	....	0.018	....
31	0.035	0.39	0.087	0.041	....	0.019	....
32	0.035	0.39	0.087	0.041	....	0.019	....
33	0.032	0.39	0.082	0.038	....	0.022	....
34	0.035	0.40	0.083	0.039	....	0.019	....
35	0.035	0.39	0.086	0.037	....	0.019	....
36	0.035	0.39	0.085	0.038	0.005	0.019	....
37	0.03	0.42	0.093	0.045	trace	0.01	0.005
38	0.04	0.40	0.091	0.042	....	0.01	....
39	0.03	0.42	0.092	0.045	....	0.01	....
40	0.04	0.42	0.086	0.040	....	0.01	....
41	0.07	0.42	0.085	0.041	....	0.01	....
42	0.06	0.45	0.093	0.040	....	0.01	....
43	0.06	0.42	0.088	0.040	....	0.01	....
44	0.09	0.42	0.088	0.040	....	0.01	....
45	0.06	0.44	0.089	0.040	....	0.01	....
46	0.06	0.43	0.087	0.041	....	0.01	....
47	0.06	0.41	0.097	0.039	....	0.006	....
48	0.08	0.40	0.083	0.037	....	0.008	....
49	0.08	0.44	0.090	0.046	....	0.006	....
50	0.08	0.42	0.093	0.046	....	0.006	....
51	0.07	0.44	0.085	0.041	0.009	0.008	0.002
52	0.05	0.44	0.086	0.041	....	0.012	....
53	0.06	0.42	0.083	0.045	....	0.008	....
54	0.05	0.42	0.089	0.041	....	0.006	....
55	0.05	0.41	0.088	0.041	....	0.006	....
56	0.05	0.42	0.091	0.045	0.009	0.004	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 1 to 12, inclusive.

TABLE III.—No. 22 GAGE OPEN-HEARTH STEEL.
SERIES A. MARKED *B*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.052	0.22	0.010	0.045	....	0.181	....
2	0.051	0.22	0.011	0.055	....	0.187	....
3	0.052	0.22	0.013	0.061	....	0.181	....
4	0.051	0.22	0.010	0.057	....	0.173	....
5	0.050	0.22	0.010	0.045	....	0.174	....
6	0.050	0.22	0.011	0.051	....	0.178	....
7	0.052	0.22	0.012	0.057	....	0.192	....
8	0.052	0.22	0.011	0.061	0.012	0.184	....
9	0.031	0.227	0.012	0.072	0.005	0.158	....
10	0.030	0.219	0.013	0.050	0.004	0.130	....
11	0.031	0.224	0.015	0.070	0.005	0.154	....
12	0.023	0.227	0.012	0.055	0.004	0.112	....
13	0.024	0.219	0.011	0.044	0.005	0.128	....
14	0.020	0.195	0.011	0.047	0.004	0.116	....
15	0.025	0.232	0.014	0.060	0.005	0.116	....
16	0.021	0.230	0.011	0.041	0.004	0.123	....
17	0.06	0.24	0.010	0.065	0.003	0.169	....
18	0.04	0.24	0.021	0.063	0.003	0.178	....
19	0.04	0.23	0.005	0.051	0.003	0.175	....
20	0.05	0.23	0.006	0.052	0.003	0.172	....
21	0.07	0.22	0.009	0.047	0.003	0.173	....
22	0.06	0.22	0.004	0.046	0.003	0.171	....
23	0.07	0.22	0.003	0.040	0.003	0.190	....
24 (std)	0.087	0.39	0.009	0.065	0.003	0.219	....
25	0.10	0.20	0.021	0.079	0.004	0.19	0.105
26	0.09	0.34	0.013	0.044	....	0.08	0.05
27	0.12	0.40	0.015	0.056	....	0.08	0.08
28	0.09	0.35	0.013	0.048	....	0.07	0.06
29	0.09	0.37	0.014	0.045	....	0.08	0.05
30	0.13	0.38	0.015	0.073	....	0.08	0.06
31	0.10	0.32	0.012	0.047	....	0.07	0.04
32	0.13	0.38	0.016	0.062	0.004	0.08	0.07
33	0.07	0.36	0.018	0.050	0.028	0.09	0.050
34	0.05	0.40	0.025	0.055	0.009	0.21	0.075
35	0.10	0.40	0.017	0.077	0.042	0.10	0.055
36	0.10	0.40	0.017	0.077	0.014	0.09	0.055
37	0.08	0.37	0.020	0.046	0.056	0.08	0.055
38	0.06	0.36	0.015	0.047	0.033	0.08	0.050
39	0.10	0.40	0.046	0.060	0.025	0.17	0.090

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 17 to 24, inclusive.

TABLE IV.—NO. 16 GAGE OPEN-HEARTH STEEL.
SERIES A. MARKED *BB*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.030	0.28	0.034	0.062	....	0.153	trace
2	0.053	0.28	0.029	0.061	....	0.153	....
3	0.053	0.28	0.030	0.060	....	0.152	....
4	0.053	0.28	0.030	0.058	....	0.144	....
5	0.050	0.29	0.031	0.060	....	0.147	....
6	0.050	0.28	0.032	0.061	....	0.144	....
7	0.053	0.28	0.030	0.062	0.086	0.142	....
8	0.053	0.28	0.028	0.063	....	0.142	....
9	0.053	0.29	0.030	0.063	....	0.152	....
10	0.057	0.30	0.016	0.044	....	0.128	....
11	0.060	0.30	0.017	0.043	....	0.133	....
12	0.035	0.327	0.010	0.054	0.004	0.122	....
13	0.071	0.324	0.014	0.052	0.003	0.133	....
14	0.051	0.313	0.016	0.062	0.005	0.133	....
15	0.055	0.319	0.012	0.049	0.003	0.133	....
16	0.047	0.302	0.010	0.048	0.004	0.126	....
17	0.047	0.289	0.016	0.050	0.003	0.133	....
18	0.058	0.321	0.016	0.048	0.004	0.117	....
19	0.036	0.270	0.011	0.036	0.003	0.133	....
20	0.092	0.495	0.015	0.037	0.004	0.028	....
21	0.094	0.486	0.016	0.029	0.003	0.034	....
22	0.083	0.486	0.016	0.028	0.004	0.030	....
23	0.06	0.49	0.024	0.028	0.009	0.041	....
24	0.06	0.49	0.027	0.023	0.009	0.045	....
25 (std)	0.05	0.49	0.018	0.026	0.009	0.040	....
26	0.06	0.49	0.024	0.026	0.009	0.039	....
27	0.06	0.49	0.015	0.028	0.009	0.044	....
28	0.07	0.49	0.017	0.029	0.009	0.040	....
29	0.05	0.34	0.020	0.043	0.009	0.128	0.093
30	0.04	0.34	0.019	0.045	0.009	0.125	0.093
31	0.04	0.34	0.021	0.043	0.009	0.127	0.101
32	0.05	0.34	0.022	0.044	0.009	0.134	0.097
33	0.06	0.34	0.017	0.036	0.009	0.136	0.085
34	0.07	0.34	0.015	0.042	0.006	0.12	0.09
35	0.07	0.35	0.015	0.038	0.003	0.11	0.10
36	0.06	0.33	0.015	0.039	0.003	0.12	0.10
37	0.12	0.42	0.009	0.023	0.004	0.10	0.07
38	0.12	0.43	0.010	0.024	0.003	0.10	0.05
39	0.18	0.46	0.011	0.027	0.005	0.09	0.06
40	0.03	0.31	0.026	0.060	0.094	0.12	0.10
41	0.04	0.30	0.026	0.061	0.094	0.13	0.12
42	0.03	0.31	0.027	0.062	0.092	0.12	0.12
43	0.03	0.33	0.027	0.060	0.088	0.13	0.11
44	0.03	0.32	0.034	0.060	0.096	0.13	0.080
45	0.05	0.32	0.035	0.060	0.132	0.12	0.100
46	0.04	0.32	0.035	0.060	0.099	0.12	0.110
47	0.06	0.32	0.037	0.061	0.088	0.13	0.120
48	0.04	0.31	0.045	0.065	0.095	0.13	0.110
49	0.04	0.32	0.028	0.063	0.094	0.11	0.110
50	0.05	0.31	0.025	0.063	0.083	0.12	0.110
51	0.04	0.32	0.026	0.065	0.085	0.12	0.115
52	0.03	0.32	0.024	0.064	0.089	0.12	0.100
53	0.02	0.32	0.033	0.061	0.102	0.14	0.100

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 23 to 33, inclusive,

TABLE V.—NO. 22 GAGE COPPER-BEARING PURE IRON.
SERIES A. MARKED *C*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.020	0.032	0.005	0.028	....	0.186	....
2	0.020	0.040	0.005	0.026	....	0.178	....
3	0.019	0.040	0.004	0.032	0.0009	0.234	....
4	0.020	0.041	0.005	0.029	....	0.222	....
5	0.022	0.031	0.005	0.028	....	0.176	....
6	0.020	0.032	0.004	0.034	....	0.187	....
7	0.019	0.040	0.003	0.032	....	0.233	....
8	0.027	0.038	0.008	0.040	0.002	0.209	....
9	0.019	0.038	0.010	0.043	0.004	0.214	....
10	0.026	0.036	0.008	0.040	0.092	0.204	....
11	0.019	0.035	0.009	0.040	0.004	0.189	....
12	0.036	0.038	0.010	0.043	0.002	0.209	....
13	0.036	0.030	0.005	0.034	0.004	0.214	....
14	0.033	0.033	0.006	0.047	0.002	0.230	....
15	0.01	0.028	0.002	0.027	0.002	0.143	0.016
16	0.01	0.03	0.003	0.025	0.002	0.147	0.048
17	0.01	0.026	0.001	0.028	0.002	0.134	0.077
18	0.01	0.026	0.003	0.029	0.002	0.147	0.061
19	0.01	0.03	0.002	0.027	0.002	0.141	0.024
20	0.01	0.028	0.001	0.027	0.002	0.140	0.024
21 (std)	0.01	0.028	0.002	0.027	0.002	0.137	0.048
22	0.06	0.04	0.005	0.034	0.004	0.19	0.015
23	0.01	0.02	0.005	0.039	....	0.20	....
24	0.02	0.02	0.004	0.032	....	0.19	....
25	0.03	0.02	0.003	0.031	....	0.18	....
26	0.02	0.03	0.003	0.030	...	0.18	....
27	0.03	0.02	0.004	0.032	....	0.18	....
28	0.05	0.03	0.004	0.031	0.004	0.18	....
29	0.02	0.02	0.005	0.041	....	0.19	....
30	0.02	0.02	0.005	0.027	....	0.17	....
31	0.02	0.02	0.003	0.039	....	0.18	....
32	0.02	0.02	0.005	0.027	0.009	0.17	....
33	0.02	0.02	0.004	0.033	....	0.17	0.012
34	0.02	0.02	0.004	0.031	....	0.17	....
35	0.02	0.02	0.005	0.031	....	0.17	....
36	0.02	0.02	0.003	0.034	0.009	0.18	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 15 to 21, inclusive.

TABLE VI.—NO. 16 GAGE COPPER-BEARING PURE IRON. SERIES A. MARKED *CC.*

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper. per cent,	Nickel, per cent.
Specified......	....	....	....	....	....	....	....
1.........	0.022	0.041	0.005	0.029	....	0.091	....
2.........	0.020	0.040	0.003	0.033	....	0.094	....
3.........	0.022	0.032	0.004	0.031	....	0.082	....
4.........	0.019	0.040	0.003	0.031	....	0.078	....
5.........	0.022	0.030	0.003	0.033	....	0.078	....
6.........	0.022	0.040	0.005	0.027	0.0028	0.066	....
7.........	0.022	0.041	0.003	0.027	....	0.125	....
8.........	0.033	0.024	0.005	0.036	0.003	0.072	....
9.........	0.026	0.024	0.004	0.030	0.004	0.056	....
10.........	0.013	0.021	0.007	0.032	0.003	0.070	....
11.........	0.036	0.024	0.006	0.032	0.004	0.076	....
12.........	0.012	0.021	0.005	0.034	0.003	0.068	....
13.........	0.029	0.024	0.006	0.037	0.004	0.048	....
14.........	0.018	0.024	0.005	0.038	0.003	0.054	....
15.........	0.01	0.023	0.001	0.034	0.002	0.061	....
16.........	0.01	0.024	0.002	0.032	0.002	0.060	....
17.........	0.01	0.019	0.001	0.040	0.002	0.069	....
18.........	0.01	0.025	0.003	0.034	0.002	0.061	....
19.........	0.01	0.020	0.002	0.034	0.002	0.065	....
20 (std)....	0.01	0.020	0.002	0.032	0.002	0.063	....
21.........	0.01	0.025	0.001	0.035	0.002	0.062	....
22.........	0.03	0.02	0.004	0.024	0.003	0.07	0.01
23.........	0.01	0.03	0.004	0.027	....	0.07	....
24.........	0.03	0.04	0.003	0.036	....	0.07	....
25.........	0.03	0.04	0.004	0.033	....	0.07	....
26.........	0.01	0.04	0.005	0.028	....	0.07	....
27.........	0.03	0.03	0.006	0.030	....	0.07	....
28.........	0.03	0.03	0.004	0.033	0.003	0.07	....
29.........	0.02	0.02	0.005	0.030	....	0.062	....
30.........	0.01	0.03	0.004	0.030	....	0.054	....
31.........	0.03	0.03	0.005	0.028	....	0.042	....
32.........	0.02	0.03	0.007	0.031	0.004	0.070	....
33.........	0.01	0.03	0.003	0.029	....	0.044	0.008
34.........	0.01	0.03	0.005	0.029	....	0.046	....
35.........	0.01	0.03	0.005	0.029	....	0.048	....
36.........	0.02	0.03	0.004	0.028	0.006	0.050	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 15 to 21, inclusive.

TABLE VII.—NO. 22 GAGE LOW-COPPER PURE IRON.

SERIES A. MARKED *D*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified......	....	....	....	....	....	....	....
1..........	0.030	0.023	0.003	0.020	....	0.035	....
2..........	0.031	0.020	0.005	0.020	....	0.035	....
3..........	0.031	0.023	0.004	0.020	0.0018	0.045	....
4..........	0.030	0.020	0.005	0.021	....	0.035	....
5..........	0.030	0.023	0.004	0.021	....	0.046	....
6..........	0.030	0.023	0.004	0.021	....	0.043	....
7..........	0.030	0.023	0.005	0.020	....	0.042	....
8..........	0.031	0.023	0.004	0.021	....	0.043	....
9..........	0.020	0.025	0.005	0.029	0.002	0.022	....
10..........	0.011	0.025	0.006	0.028	0.002	0.020	....
11..........	0.011	0.027	0.006	0.028	0.002	0.020	....
12..........	0.011	0.025	0.005	0.029	0.002	0.022	....
13..........	0.020	0.025	0.004	0.030	0.002	0.018	....
14..........	0.011	0.023	0.005	0.028	0.002	0.022	....
15..........	0.011	0.030	0.004	0.030	0.002	0.020	....
16..........	0.013	0.020	0.003	0.029	0.002	0.017	....
17..........	0.01	0.022	0.003	0.024	0.002	0.019	....
18..........	0.01	0.021	0.003	0.016	0.002	0.022	....
19..........	0.01	0.020	0.003	0.014	0.002	0.019	....
20 (std)....	0.01	0.02	0.003	0.020	0.002	0.019	....
21..........	0.01	0.019	0.003	0.023	0.002	0.028	....
22..........	0.01	0.020	0.003	0.023	0.002	0.025	....
23..........	0.01	0.022	0.003	0.021	0.002	0.028	....
24..........	0.01	0.021	0.003	0.020	0.002	0.019	....
25..........	0.01	0.03	0.004	0.017	trace	0.02	0.01
26..........	0.01	0.04	0.003	0.017	....	0.02	0.02
27..........	0.01	0.03	0.003	0.017	....	0.02	0.02
28..........	0.01	0.04	0.003	0.019	....	0.02	0.01
29..........	0.02	0.05	0.003	0.017	....	0.02	0.02
30..........	0.02	0.05	0.002	0.018	....	0.02	0.02
31..........	0.01	0.04	0.002	0.018	....	0.02	0.02
32..........	0.02	0.05	0.003	0.019	....	0.02	0.02
33..........	0.02	0.03	0.004	0.019	trace	0.02	0.02
34..........	0.02	0.02	0.005	0.020	....	0.010	....
35..........	0.03	0.02	0.004	0.021	....	0.010	....
36..........	0.02	0.02	0.003	0.021	....	0.014	....
37..........	0.03	0.02	0.003	0.020	....	0.012	....
38..........	0.03	0.02	0.003	0.021	0.004	0.016	0.006
39..........	0.02	0.02	0.004	0.023	....	0.020	....
40..........	0.05	0.02	0.003	0.022	....	0.024	....
41..........	0.03	0.02	0.005	0.022	....	0.026	....
42..........	0.06	0.02	0.005	0.019	0.004	0.022	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 17 to 24, inclusive.

TABLE VIII.—NO. 16 GAGE LOW-COPPER PURE IRON. SERIES A. MARKED *DD*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.030	0.022	0.003	0.032	....	0.042	....
2	0.032	0.030	0.002	0.034	....	0.048	....
3	0.031	0.022	0.003	0.029	....	0.040	....
4	0.030	0.030	0.003	0.029	....	0.037	....
5	0.033	0.022	0.004	0.024	....	0.032	....
6	0.034	0.022	0.002	0.032	....	0.037	....
7	0.033	0.022	0.005	0.034	0.0018	0.056	....
8	0.030	0.030	0.004	0.034	....	0.045	....
9	0.032	0.022	0.004	0.034	....	0.038	....
10	0.032	0.030	0.004	0.035	....	0.030	....
11	0.034	0.030	0.004	0.029	....	0.040	....
12	0.034	0.030	0.004	0.028	....	0.038	....
13	0.013	0.027	0.004	0.024	0.002	0.020	....
14	0.011	0.027	0.007	0.026	0.001	0.024	....
15	0.011	0.025	0.003	0.028	0.002	0.020	....
16	0.014	0.021	0.003	0.026	0.001	0.026	....
17	0.011	0.023	0.004	0.025	0.002	0.014	....
18	0.011	0.022	0.004	0.025	0.001	0.024	....
19	0.017	0.025	0.004	0.026	0.002	0.016	....
20	0.011	0.025	0.006	0.029	0.001	0.016	....
21	0.015	0.025	0.003	0.028	0.002	0.028	....
22	0.012	0.025	0.004	0.030	0.001	0.018	....
23	0.021	0.025	0.003	0.026	0.002	0.018	....
24	0.010	0.022	0.004	0.028	0.002	0.026	....
25	0.01	0.016	0.003	0.026	0.005	0.025	....
26	0.01	0.015	0.003	0.029	0.006	0.025	....
27	0.01	0.016	0.003	0.024	0.006	0.035	....
28 (std.)	0.01	0.016	0.003	0.024	0.006	0.032	....
29	0.01	0.016	0.003	0.026	0.006	0.032	....
30	0.01	0.016	0.003	0.029	0.006	0.038	....
31	0.01	0.016	0.003	0.028	0.006	0.035	....
32	0.01	0.016	0.003	0.022	0.006	0.032	....
33	0.01	0.016	0.003	0.024	0.006	0.035	....
34	0.01	0.016	0.003	0.025	0.006	0.035	....
35	0.01	0.016	0.003	0.029	0.006	0.035	....
36	0.01	0.016	0.003	0.027	0.006	0.035	....
37	0.02	0.03	0.003	0.025	trace	0.03	0.02
38	0.02	0.04	0.003	0.022	....	0.03	0.03
39	0.02	0.04	0.003	0.022	....	0.03	0.03
40	0.02	0.05	0.003	0.023	....	0.03	0.03
41	0.01	0.05	0.003	0.024	....	0.02	0.02
42	0.02	0.05	0.003	0.027	....	0.03	0.02
43	0.02	0.06	0.003	0.028	....	0.03	0.03
44	0.02	0.06	0.003	0.027	....	0.03	0.03
45	0.02	0.04	0.003	0.031	....	0.02	0.02
46	0.02	0.05	0.003	0.026	....	0.02	0.02
47	0.02	0.05	0.003	0.028	....	0.03	0.02
48	0.02	0.06	0.003	0.026	trace	0.02	0.03
49	0.03	0.02	0.003	0.020	....	0.028	....
50	0.03	0.02	0.005	0.025	....	0.020	....
51	0.04	0.02	0.004	0.021	....	0.022	....
52	0.02	0.02	0.004	0.022	....	0.022	....
53	0.01	0.03	0.006	0.023	0.004	0.016	0.006
54	0.02	0.02	0.006	0.024	....	0.020	....
55	0.02	0.02	0.005	0.024	....	0.018	....
56	0.01	0.02	0.005	0.028	....	0.022	....
57	0.02	0.02	0.004	0.021	....	0.018	....
58	0.01	0.03	0.004	0.024	0.004	0.012	....
59	0.02	0.03	0.005	0.021	....	0.020	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 25 to 36, inclusive.

TABLE IX.—NO. 22 GAGE PUDDLED IRON.
SERIES A. MARKED *E*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified......	....	....	....	....	....	....	....
1.........	0.040	0.033	0.132	0.020	0.131	0.275	....
2.........	0.040	0.033	0.112	0.021	0.121	0.237	....
3.........	0.045	0.030	0.112	0.019	0.113	0.234	....
4.........	0.047	0.036	0.130	0.021	0.126	0.240	....
5.........	0.045	0.030	0.110	0.021	0.159	0.203	....
6.........	0.045	0.026	0.116	0.021	0.112	0.254	....
7.........	0.040	0.030	0.118	0.020	0.141	0.333	....
8.........	0.038	0.030	0.097	0.020	0.103	0.229	....
9.........	0.029	0.030	0.099	0.018	0.077	0.268	....
10.........	0.011	0.033	0.113	0.023	0.073	0.239	....
11.........	0.026	0.038	0.120	0.024	0.159	0.244	....
12.........	0.051	0.035	0.115	0.022	0.126	0.249	....
13.........	0.038	0.037	0.110	0.020	0.117	0.263	....
14.........	0.025	0.030	0.096	0.023	0.101	0.275	....
15.........	0.02	0.031	0.122	0.023	0.119	0.311	....
16.........	0.01	0.035	0.137	0.025	0.147	0.311	....
17 (std)....	0.02	0.028	0.114	0.026	0.238	0.281	....
18.........	0.02	0.036	0.122	0.023	0.179	0.276	....
19.........	0.02	0.035	0.134	0.023	0.157	0.306	....
20.........	0.03	0.032	0.107	0.021	0.176	0.30	....
21.........	0.02	0.035	0.127	0.021	0.172	0.294	....
22.........	0.04	0.05	0.103	0.018	0.13	0.31	0.04
23.........	0.03	0.05	0.106	0.019	0.12	0.32	0.04
24.........	0.04	0.05	0.107	0.020	0.15	0.31	0.04
25.........	0.04	0.05	0.101	0.019	0.11	0.31	0.03
26.........	0.05	0.07	0.127	0.020	0.15	0.32	0.03
27.........	0.02	0.06	0.120	0.021	0.14	0.32	0.04
28.........	0.03	0.06	0.124	0.023	0.14	0.31	0.03
29.........	0.06	0.02	0.097	0.019	0.022	0.28	0.020
30.........	0.03	0.02	0.114	0.021	0.126	0.28	0.025
31.........	0.03	0.02	0.104	0.020	0.122	0.31	0.020
32.........	0.02	0.02	0.111	0.021	0.141	0.31	0.020
33.........	0.05	0.02	0.113	0.019	0.125	0.29	0.025
34.........	0.04	0.02	0.123	0.021	0.141	0.29	0.020
35.........	0.03	0.02	0.104	0.019	0.135	0.30	0.012
36.........	0.02	0.02	0.101	0.020	0.141	0.31	0.015

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 15 to 21, inclusive.

TABLE X.—NO. 16 GAGE PUDDLED IRON.
SERIES A. MARKED *EE*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified......	....	....	....	....	....	....	....
1.........	0.037	0.023	0.112	0.018	0.123	0.320	....
2.........	0.035	0.026	0.120	0.018	0.136	0.352	....
3.........	0.037	0.026	0.117	0.019	0.135	0.333	....
4.........	0.037	0.026	0.110	0.017	0.116	0.310	....
5.........	0.035	0.026	0.122	0.020	0.134	0.286	....
6.........	0.035	0.026	0.124	0.019	0.100	0.225	....
7.........	0.037	0.026	0.116	0.018	0.113	0.182	....
8.........	0.088	0.028	0.110	0.020	0.091	0.314	....
9.........	0.040	0.028	0.110	0.020	0.136	0.280	....
10.........	0.040	0.035	0.109	0.022	0.139	0.306	....
11.........	0.028	0.025	0.104	0.019	0.066	0.314	....
12.........	0.032	0.025	0.006	0.022	0.066	0.309	....
13.........	0.019	0.030	0.109	0.019	0.079	0.263	....
14.........	0.024	0.030	0.109	0.017	0.115	0.311	....
15.........	0.025	0.020	0.127	0.020	0.150	0.340	....
16.........	0.025	0.020	0.133	0.018	0.150	0.332	....
17 (std)....	0.025	0.020	0.123	0.016	0.097	0.342	....
18.........	0.025	0.020	0.130	0.020	0.138	0.340	....
19.........	0.025	0.020	0.170	0.020	0.166	0.346	....
20.........	0.025	0.020	0.136	0.019	0.147	0.342	....
21.........	0.025	0.020	0.145	0.020	0.157	0.340	....
22.........	0.03	0.06	0.124	0.019	0.15	0.34	0.04
23.........	0.03	0.05	0.112	0.017	0.13	0.34	0.03
24.........	0.03	0.04	0.116	0.017	0.16	0.33	0.04
25.........	0.03	0.06	0.128	0.018	0.14	0.34	0.04
26.........	0.03	0.07	0.117	0.017	0.12	0.34	0.04
27.........	0.02	0.05	0.122	0.016	0.13	0.33	0.03
28.........	0.04	0.06	0.111	0.016	0.11	0.35	0.04
29.........	0.05	0.02	0.101	0.016	0.112	0.33	0.020
30.........	0.05	0.03	0.118	0.018	0.112	0.31	0.010
31.........	0.05	0.02	0.136	0.019	0.150	0.29	0.010
32.........	0.03	0.02	0.128	0.019	0.136	0.32	0.010
33.........	0.04	0.02	0.098	0.017	0.131	0.29	0.025
34.........	0.04	0.02	0.109	0.019	0.131	0.32	0.015
35.........	0.05	0.02	0.111	0.016	0.126	0.32	0.015
36.........	0.05	0.02	0.115	0.019	0.125	0.31	0.020

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 15 to 21, inclusive.

TABLE XI.—NO. 22 GAGE COPPER-BEARING BASIC OPEN-HEARTH STEEL. SERIES A. MARKED *H*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.090	0.36	0.010	0.024	....	0.277	....
2	0.095	0.36	0.010	0.025	....	0.258	....
3	0.095	0.36	0.010	0.025	....	0.259	....
4	0.100	0.37	0.010	0.024	....	0.264	....
5	0.100	0.36	0.010	0.024	....	0.272	....
6	0.095	0.36	0.009	0.024	0.0075	0.272	....
7	0.100	0.36	0.009	0.025	....	0.254	....
8	0.100	0.37	0.011	0.026	....	0.240	....
9	0.100	0.37	0.010	0.025	....	0.256	....
10	0.105	0.37	0.009	0.026	....	0.237	....
11	0.100	0.37	0.011	0.024	....	0.256	....
12	0.055	0.352	0.011	0.032	0.002	0.235	....
13	0.065	0.380	0.013	0.032	0.003	0.250	....
14	0.055	0.370	0.011	0.034	0.002	0.240	....
15	0.068	0.380	0.011	0.031	0.003	0.250	....
16	0.057	0.369	0.013	0.032	0.002	0.230	....
17	0.062	0.373	0.011	0.030	0.003	0.245	....
18	0.074	0.375	0.011	0.035	0.002	0.240	....
19	0.075	0.378	0.013	0.038	0.003	0.224	....
20	0.044	0.385	0.011	0.030	0.002	0.235	....
21	0.058	0.363	0.014	0.035	0.003	0.240	....
22	0.068	0.350	0.011	0.031	0.002	0.250	....
23	0.06	0.39	0.011	0.028	0.005	0.246	....
24	0.05	0.39	0.010	0.028	0.005	0.243	....
25	0.06	0.39	0.009	0.031	0.005	0.240	....
26	0.06	0.39	0.008	0.026	0.005	0.243	....
27	0.06	0.39	0.009	0.031	0.005	0.239	....
28	0.06	0.39	0.009	0.026	0.005	0.247	....
29	0.05	0.39	0.005	0.035	0.005	0.244	....
30	0.06	0.39	0.011	0.027	0.005	0.246	....
31	0.05	0.39	0.010	0.028	0.005	0.249	....
32 (std)	0.058	0.39	0.010	0.024	0.005	0.242	....
33	0.04	0.39	0.010	0.026	0.005	0.245	....
34	0.07	0.39	0.012	0.023	trace	0.25	0.04
35	0.07	0.38	0.012	0.024	....	0.24	0.05
36	0.05	0.41	0.010	0.023	....	0.25	0.03
37	0.05	0.41	0.010	0.022	....	0.24	0.03
38	0.06	0.43	0.008	0.021	....	0.24	0.04
39	0.08	0.46	0.057	0.029	....	0.25	0.03
40	0.09	0.45	0.055	0.028		0.25	trace
41	0.08	0.44	0.058	0.029	....	0.26	0.01
42	0.09	0.45	0.058	0.030	....	0.26	0.02
43	0.09	0.44	0.060	0.029	....	0.25	trace
44	0.08	0.44	0.055	0.029	trace	0.25	0.01
45	0.06	0.38	0.013	0.029	....	0.23	0.030
46	0.05	0.38	0.013	0.027	....	0.22	0.030
47	0.06	0.38	0.011	0.026	....	0.21	0.025
48	0.05	0.37	0.013	0.027	....	0.23	0.030
49	0.05	0.39	0.012	0.024		0.23	0.015
50	0.06	0.39	0.011	0.025	0.004	0.24	0.030
51	0.06	0.37	0.012	0.024	....	0.24	0.030
52	0.05	0.39	0.013	0.026	....	0.23	0.035
53	0.06	0.38	0.011	0.024	....	0.23	0.030
54	0.07	0.39	0.012	0.025		0.23	0.030
55	0.06	0.38	0.013	0.024	0.006	0.21	0.030

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 23 to 33, inclusive.

TABLE XII.—NO. 16 GAGE COPPER-BEARING BASIC OPEN-HEARTH STEEL SERIES A. MARKED *HH*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified......	....	....	....	....	....	....	....
1.........	0.097	0.37	0.011	0.024	....	0.253	....
2.........	0.090	0.37	0.009	0.023	....	0.251	....
3.........	0.092	0.36	0.010	0.023	....	0.240	....
4.........	0.100	0.37	0.010	0.029	....	0.246	....
5.........	0.095	0.38	0.011	0.026	....	0.258	....
6.........	0.097	0.37	0.010	0.024	0.0084	0.238	....
7.........	0.095	0.37	0.010	0.024	....	0.245	....
8.........	0.100	0.37	0.010	0.026	....	0.253	....
9.........	0.100	0.36	0.011	0.023	....	0.200	....
10.........	0.100	0.37	0.010	0.023	....	0.203	....
11.........	0.067	0.362	0.011	0.025	0.003	0.250	....
12.........	0.069	0.352	0.012	0.026	0.002	0.250	....
13.........	0.070	0.365	0.009	0.025	0.003	0.255	....
14.........	0.054	0.359	0.012	0.025	0.002	0.250	....
15.........	0.093	0.351	0.009	0.028	0.003	0.265	....
16.........	0.051	0.373	0.012	0.026	0.002	0.255	....
17.........	0.080	0.348	0.013	0.025	0.003	0.250	....
18.........	0.095	0.370	0.013	0.025	0.002	0.260	....
19.........	0.053	0.348	0.011	0.024	0.003	0.250	....
20.........	0.080	0.351	0.011	0.026	0.002	0.250	....
21.........	0.06	0.38	0.008	0.026	0.005	0.239	....
22 (std)....	0.044	0.38	0.009	0.026	0.005	0.242	....
23.........	0.04	0.38	0.006	0.026	0.005	0.248	....
24.........	0.05	0.38	0.009	0.026	0.005	0.246	....
25.........	0.06	0.38	0.005	0.025	0.005	0.250	....
26.........	0.05	0.38	0.006	0.024	0.005	0.241	....
27.........	0.05	0.38	0.005	0.025	0.005	0.240	....
28.........	0.05	0.38	0.008	0.025	0.005	0.246	....
29.........	0.06	0.38	0.008	0.025	0.005	0.245	....
30.........	0.05	0.38	0.008	0.024	0.005	0.240	....
31.........	0.06	0.37	0.018	0.028	trace	0.23	0.01
32.........	0.06	0.34	0.017	0.028	....	0.23	0.01
33.........	0.06	0.36	0.018	0.028	....	0.23	0.02
34.........	0.06	0.34	0.020	0.027	....	0.22	0.01
35.........	0.06	0.37	0.024	0.031	....	0.22	0.01
36.........	0.07	0.35	0.023	0.029	....	0.22	0.01
37.........	0.11	0.39	0.016	0.025	....	0.25	0.01
38.........	0.10	0.41	0.011	0.025	....	0.25	0.01
39.........	0.12	0.41	0.016	0.025	....	0.25	0.01
40.........	0.05	0.38	0.017	0.028	trace	0.23	0.01
41.........	0.08	0.37	0.010	0.027	....	0.20	0.030
42.........	0.07	0.38	0.011	0.026	....	0.21	0.030
43.........	0.08	0.38	0.010	0.025	....	0.20	0.030
44.........	0.08	0.39	0.012	0.026	....	0.21	0.030
45.........	0.08	0.39	0.011	0.027	0.007	0.24	0.030
46.........	0.08	0.39	0.010	0.025	....	0.23	0.030
47.........	0.08	0.39	0.009	0.027	....	0.21	0.030
48.........	0.07	0.39	0.010	0.024	....	0.21	0.030
49.........	0.08	0.40	0.009	0.025	....	0.23	0.030
50.........	0.08	0.39	0.012	0.028	0.006	0.22	0.030

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 21 to 30, inclusive.

TABLE XIII.—NO. 22 GAGE COPPER-BEARING BESSEMER STEEL. SERIES A. MARKED *I*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.052	0.35	0.094	0.064	....	0.256	....
2	0.066	0.35	0.095	0.068	....	0.246	....
3	0.060	0.36	0.098	0.066	....	0.264	....
4	0.048	0.35	0.098	0.064	....	0.243	....
5	0.054	0.35	0.098	0.067	....	0.245	....
6	0.060	0.35	0.097	0.063	....	0.247	....
7	0.054	0.36	0.096	0.063	....	0.256	....
8	0.050	0.35	0.099	0.065	....	0.243	....
9	0.068	0.36	0.096	0.063	....	0.250	....
10	0.032	0.36	0.097	0.064	0.0094	0.240	....
11	0.062	0.35	0.099	0.064	....	0.262	....
12	0.028	0.329	0.097	0.074	0.003	0.250	....
13	0.064	0.329	0.097	0.068	0.004	0.260	....
14	0.038	0.284	0.100	0.072	0.003	0.240	....
15	0.048	0.319	0.094	0.064	0.004	0.230	....
16	0.042	0.343	0.100	0.071	0.003	0.250	....
17	0.040	0.348	0.104	0.078	0.004	0.275	....
18	0.031	0.321	0.099	0.072	0.003	0.260	....
19	0.059	0.370	0.088	0.067	0.004	0.235	....
20	0.039	0.354	0.092	0.065	0.003	0.355	....
21	0.050	0.332	0.101	0.073	0.004	0.235	....
22	0.028	0.354	0.110	0.065	0.003	0.209	....
23	0.025	0.39	0.091	0.068	0.012	0.271	....
24	0.03	0.41	0.101	0.088	0.012	0.269	....
25	0.025	0.39	0.112	0.071	0.012	0.270	....
26	0.02	0.39	0.095	0.071	0.012	0.274	....
27	0.03	0.39	0.090	0.071	0.012	0.273	....
28	0.02	0.39	0.095	0.068	0.012	0.268	....
29	0.03	0.41	0.087	0.068	0.012	0.265	....
30	0.02	0.39	0.089	0.068	0.012	0.263	....
31	0.02	0.41	0.087	0.066	0.012	0.259	....
32	0.03	0.40	0.091	0.074	0.012	0.260	....
33 (std)	0.025	0.41	0.092	0.064	0.012	0.262	....
34	0.03	0.37	0.102	0.067	0.007	0.26	0.005
35	0.03	0.38	0.101	0.070	....	0.26	....
36	0.04	0.37	0.095	0.068	....	0.25	....
37	0.05	0.37	0.094	0.066	....	0.26	....
38	0.04	0.37	0.091	0.062	....	0.25	....
39	0.03	0.38	0.094	0.063	....	0.24	....
40	0.05	0.37	0.094	0.064	....	0.25	....
41	0.03	0.37	0.104	0.068	....	0.26	....
42	0.04	0.37	0.104	0.068	....	0.26	....
43	0.05	0.39	0.103	0.070	....	0.26	....
44	0.03	0.38	0.103	0.067	0.011	0.26	....
45	0.06	0.37	0.102	0.074	....	0.23	....
46	0.06	0.37	0.096	0.065	....	0.24	....
47	0.04	0.36	0.097	0.070	....	0.21	....
48	0.04	0.36	0.098	0.066	....	0.25	....
49	0.05	0.37	0.092	0.065	0.006	0.21	0.002
50	0.04	0.36	0.104	0.070	....	0.24	....
51	0.04	0.37	0.098	0.070	....	0.22	....
52	0.03	0.36	0.103	0.061	....	0.26	....
53	0.03	0.36	0.096	0.061	....	0.24	....
54	0.03	0.37	0.094	0.068	0.009	0.22	....
55	0.02	0.36	0.098	0.068	....	0.23	....

NOTE. The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 23 to 55, inclusive.

TABLE XIV.—NO. 16 GAGE COPPER-BEARING BESSEMER STEEL. SERIES A. MARKED *II.*

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.057	0.35	0.090	0.061	....	0.280	....
2	0.069	0.36	0.091	0.061	....	0.266	....
3	0.060	0.35	0.091	0.062	....	0.264	....
4	0.060	0.36	0.091	0.060	....	0.266	....
5	0.062	0.36	0.090	0.062	....	0.270	....
6	0.060	0.36	0.095	0.064	....	0.264	....
7	0.060	0.35	0.094	0.062	....	0.269	....
8	0.064	0.35	0.098	0.066	....	0.256	....
9	0.055	0.35	0.096	0.062	0.0103	0.248	....
10	0.060	0.35	0.098	0.064	....	0.253	....
11	0.057	0.36	0.098	0.060	....	0.270	....
12	0.048	0.360	0.091	0.069	0.003	0.219	....
13	0.061	0.365	0.102	0.072	0.003	0.255	....
14	0.053	0.370	0.096	0.067	0.003	0.199	....
15	0.051	0.375	0.092	0.068	0.003	0.240	....
16	0.046	0.332	0.098	0.072	0.003	0.224	....
17	0.052	0.370	0.093	0.072	0.003	0.250	....
18	0.061	0.342	0.098	0.066	0.003	0.265	....
19	0.035	0.372	0.100	0.072	0.003	0.230	....
20	0.001	0.340	0.080	0.067	0.003	0.260	....
21	0.058	0.380	0.080	0.067	0.003	0.256	....
22	0.064	0.360	0.095	0.067	0.003	0.209	....
23	0.08	0.37	0.073	0.067	0.008	0.248	....
24	0.09	0.35	0.086	0.068	0.008	0.246	....
25	0.04	0.37	0.101	0.069	0.008	0.246	....
26	0.05	0.37	0.071	0.071	0.008	0.244	....
27 (std)	0.083	0.37	0.094	0.069	0.008	0.242	....
28	0.08	0.37	0.084	0.079	0.008	0.243	....
29	0.08	0.37	0.083	0.070	0.008	0.243	....
30	0.06	0.37	0.101	0.067	0.008	0.241	....
31	0.08	0.37	0.095	0.067	0.008	0.240	....
32	0.08	0.37	0.085	0.068	0.008	0.240	....
33	0.06	0.37	0.089	0.067	0.008	0.239	....
34	0.05	0.41	0.104	0.069	0.006	0.26	0.005
35	0.05	0.39	0.102	0.063	....	0.25	....
36	0.05	0.40	0.099	0.065	....	0.25	....
37	0.05	0.39	0.098	0.063	....	0.25	....
38	0.05	0.41	0.097	0.063	....	0.25	....
39	0.05	0.39	0.098	0.064	....	0.25	....
40	0.05	0.41	0.099	0.066	....	0.25	....
41	0.06	0.37	0.098	0.070	....	0.26	....
42	0.08	0.40	0.110	0.073	....	0.25	....
43	0.08	0.40	0.106	0.069	....	0.26	....
44	0.07	0.37	0.099	0.061	0.006	0.25	....
45	0.05	0.36	0.100	0.066	....	0.23	....
46	0.05	0.37	0.097	0.067	....	0.25	....
47	0.05	0.37	0.095	0.064	....	0.24	....
48	0.05	0.37	0.094	0.067	....	0.25	....
49	0.06	0.37	0.099	0.064	0.009	0.22	0.001
50	0.05	0.36	0.094	0.065	....	0.22	....
51	0.06	0.38	0.098	0.066	....	0.24	....
52	0.03	0.38	0.098	0.071	....	0.26	....
53	0.06	0.37	0.096	0.064	....	0.25	....
54	0.04	0.40	0.096	0.057	0.013	0.22	....
55	0.05	0.39	0.099	0.065	....	0.22	....
56	0.06	0.37	0.097	0.066	....	0.25	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 23 to 33, inclusive,

TABLE XV.—NO. 22 GAGE COPPER-BEARING ACID OPEN-HEARTH STEEL. SERIES A. MARKED *K*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.130	0.43	0.084	0.042	....	0.230	....
2	0.130	0.44	0.085	0.041	....	0.256	....
3	0.136	0.44	0.089	0.043	....	0.221	....
4	0.130	0.44	0.090	0.042	....	0.245	....
5	0.120	0.43	0.092	0.040	....	0.222	....
6	0.123	0.43	0.092	0.040	....	0.227	....
7	0.136	0.44	0.080	0.037	....	0.264	....
8	0.130	0.44	0.092	0.039	0.0037	0.245	....
9	0.136	0.43	0.082	0.039	...	0.208	....
10	0.100	0.425	0.082	0.049	0.002	0.224	....
11	0.092	0.427	0.081	0.044	0.003	0.199	....
12	0.095	0.427	0.084	0.049	0.002	0.205	....
13	0.103	0.427	0.082	0.049	0.003	0.219	....
14	0.092	0.397	0.084	0.047	0.002	0.214	....
15	0.083	0.392	0.083	0.050	0.003	0.199	....
16	0.075	0.425	0.080	0.047	0.002	0.204	....
17	0.082	0.397	0.084	0.047	0.003	0.219	....
18	0.080	0.425	0.083	0.048	0.002	0.209	....
19 (std)	0.091	0.44	0.085	0.045	trace	0.256	....
20	0.09	0.45	0.081	0.046	trace	0.259	....
21	0.10	0.45	0.106	0.044	trace	0.255	....
22	0.10	0.45	0.090	0.045	trace	0.259	....
23	0.10	0.45	0.083	0.044	trace	0.256	....
24	0.11	0.45	0.092	0.043	trace	0.253	....
25	0.14	0.46	0.116	0.057	trace	0.252	....
26	0.11	0.45	0.112	0.059	trace	0.252	....
27	0.10	0.45	0.088	0.048	trace	0.252	
28	0.13	0.45	0.084	0.060	trace	0.252	
29	0.12	0.48	0.098	0.051	trace	0.25	0.005
30	0.10	0.47	0.096	0.048	....	0.24	....
31	0.09	0.47	0.105	0.050	....	0.24	....
32	0.13	0.47	0.105	0.050	....	0.25	....
33	0.09	0.44	0.086	0.041	....	0.24	
34	0.12	0.47	0.101	0.047	....	0.25	
35	0.13	0.47	0.104	0.050	....	0.25	
36	0.11	0.47	0.092	0.036	....	0.25	
37	0.11	0.49	0.107	0.050	....	0.25	
38	0.11	0.47	0.101	0.048	trace	0.25	
39	0.10	0.45	0.093	0.053	....	0.25	
40	0.09	0.45	0.108	0.053	....	0.23	
41	0.09	0.46	0.090	0.044	....	0.23	
42	0.10	0.46	0.092	0.049	....	0.24	
43	0.08	0.47	0.083	0.041	0.011	0.24	0.008
44	0.10	0.46	0.084	0.045	....	0.23	....
45	0.11	0.46	0.110	0.053	....	0.24	....
46	0.10	0.45	0.083	0.046	....	0.23	....
47	0.09	0.46	0.082	0.047	....	0.23	....
48	0.11	0.46	0.077	0.043	0.008	0.22	....

NOTE. The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 19 to 28, inclusive.

TABLE XVI.—NO. 16 GAGE COPPER-BEARING ACID OPEN-HEARTH STEEL. SERIES A. MARKED *KK*.

Sheet No.	Carbon, per cent.	Manganese, per cent.	Phosphorus, per cent.	Sulfur, per cent.	Silicon, per cent.	Copper, per cent.	Nickel, per cent.
Specified	....	....	....	....	....	....	....
1	0.10	0.45	0.078	0.038	....	0.25	....
2	0.07	0.45	0.081	0.040	....	0.25	....
3	0.09	0.45	0.078	0.040	....	0.22	....
4	0.10	0.45	0.080	0.039	....	0.23	....
5	0.08	0.46	0.079	0.039	0.011	0.21	0.008
6	0.08	0.45	0.080	0.040	....	0.22	....
7	0.10	0.46	0.081	0.038	....	0.22	....
8	0.070	0.46	0.081	0.041	....	0.21	....
9	0.11	0.46	0.095	0.049	....	0.21	....
10	0.09	0.45	0.097	0.052	0.007	0.22	....
11	0.10	0.45	0.088	0.046	....	0.22	....
12	0.10	0.45	0.078	0.042	....	0.22	....
13	0.11	0.46	0.078	0.040	trace	0.24	0.010
14	0.09	0.47	0.084	0.038	....	0.24	....
15	0.11	0.47	0.087	0.038	....	0.24	....
16	0.11	0.45	0.089	0.038	....	0.23	....
17	0.10	0.47	0.087	0.037	....	0.24	....
18	0.10	0.45	0.091	0.039	....	0.23	....
19	0.13	0.47	0.104	0.049	....	0.24	....
20	0.12	0.48	0.098	0.042	....	0.24	....
21	0.11	0.48	0.086	0.039	....	0.24	....
22	0.12	0.47	0.094	0.049	....	0.24	....
23	0.10	0.45	0.083	0.037	....	0.24	....
24	0.09	0.47	0.092	0.042	trace	0.24	....
25	0.10	0.42	0.101	0.049	trace	0.240	....
26	0.11	0.42	0.089	0.042	trace	0.240	....
27	0.11	0.43	0.084	0.043	trace	0.244	....
28	0.10	0.42	0.083	0.042	trace	0.247	....
29	0.11	0.42	0.075	0.042	trace	0.247	....
30	0.10	0.42	0.077	0.044	trace	0.246	....
31	0.12	0.42	0.073	0.051	trace	0.245	....
32 (std)	0.113	0.42	0.093	0.041	trace	0.241	....
33	0.11	0.42	0.082	0.044	trace	0.246	....
34	0.10	0.42	0.083	0.043	trace	0.240	....
35	0.11	0.42	0.097	0.046	trace	0.248	....
36	0.12	0.42	0.084	0.041	trace	0.246	....
37	0.099	0.397	0.080	0.043	0.004	0.214	....
38	0.100	0.390	0.083	0.042	0.003	0.199	....
39	0.101	0.402	0.081	0.043	0.004	0.199	....
40	0.112	0.405	0.085	0.050	0.003	0.204	....
41	0.109	0.392	0.082	0.049	0.004	0.209	....
42	0.082	0.395	0.083	0.044	0.003	0.219	....
43	0.093	0.425	0.080	0.047	0.004	0.204	....
44	0.100	0.382	0.082	0.043	0.003	0.209	....
45	0.102	0.380	0.080	0.044	0.004	0.214	....
46	0.084	0.385	0.085	0.044	0.003	0.214	....
47	0.103	0.395	0.080	0.042	0.004	0.199	....
48	0.133	0.42	0.083	0.042	....	0.254	....
49	0.130	0.42	0.081	0.041	....	0.246	....
50	0.126	0.43	0.082	0.042	....	0.248	....
51	0.140	0.42	0.083	0.042	....	0.246	....
52	0.133	0.42	0.083	0.041	....	0.259	....
53	0.130	0.42	0.083	0.041	....	0.256	....
54	0.136	0.43	0.081	0.045	....	0.264	....
55	0.130	0.43	0.082	0.042	....	0.269	....
56	0.133	0.43	0.083	0.043	0.0084	0.259	....
57	0.133	0.42	0.080	0.042	....	0.254	....
58	0.143	0.43	0.093	0.048	....	0.256	....

NOTE.—The carbon in sample marked standard (std.) was determined by combustion and this sample was used as a standard for the determination of carbon by color in samples Nos. 25 to 36, inclusive.

REPORT OF COMMITTEE A-6

ON

MAGNETIC PROPERTIES OF IRON AND STEEL.

The work of Committee A-6 for the past year has been carried on by informal conferences. As a result of this informal work the committee recommends the following changes in the Standard Tests for Magnetic Properties of Iron and Steel (Serial Designation: A 34-14)[1] for publication as tentative:

Strike out the last two paragraphs, which read:

> "The standard test for rods intended for permanent magnets shall consist in the measurement of the magnetizing force, the residual induction, and the coercive force corresponding to a maximum induction of 14,000 gausses.
>
> "Standard tests shall be made by the Burrows compensated double-yoke method (described in the *Standard Electrical Engineer's Handbook*, and also in *Technical Paper No. 117 of the Bureau of Standards*).",

and insert the following:

RESIDUAL INDUCTION AND COERCIVE FORCE.

> "The magnetic induction which exists in a piece of magnetic material when the magnetizing force has been reduced to zero is called the residual induction. The magnetizing force required to reduce this induction to zero is called the coercive force. The values of the residual induction and the coercive force depend upon the previous magnetic history. If the magnetic material has been normalized by proper demagnetization and repeated reversals of the magnetizing force, the corresponding quantities are called the normal residual induction (B_r) and the normal coercive force (H_c).

---

[1] 1915 Year-Book, p. 195.

"The standard data for material intended for permanent magnets shall consist of the normal induction (B), the normal residual induction (B_r), and the normal coercive force (H_c) corresponding to a magnetizing force of 200 gausses.

"The standard magnetic data shall be determined by the Burrows compensated double-yoke method on test specimens prepared as indicated below.

"*Sampling.*—Each mill heat or lot shall be marked separately. The test sample shall consist of one test specimen from each of six different bars.

"*Heat Treatment.*—For steels of the following approximate chemical composition:

Carbon	0.50 – 0.70	per cent
Manganese	0.50 – 1.00	"
Phosphorus	0.05	"
Sulfur	0.03	"
Silicon	0.10	"

heat the specimen to 825° C. (1517° F.) and quench in water at 20° C.

"For tungsten steel, heat the specimen to 845° C. (1550° F.) and quench in water at 20° C.

"For other alloy steels, the heat treatment is to be determined by practical tests on test specimen.

"The furnace shall be of such size that the specimen is heated to the required temperature in not over 30 minutes.

"The furnace temperatures given above shall not vary by more than 10° C.

"On quenching, the test specimen shall be removed quickly from the furnace. The test specimen shall not be allowed to cool over 10° C., after leaving the furnace and before immersion.

"Immerse end-on or edgewise. The quantity of water shall be such that after quenching it is not over 50° C."

The committee further recommends that certain changes in phraseology be made in the following paragraph of the Standard Tests, for the sake of clearer expression; the new words are given in italics, and those to be omitted are shown in parentheses:

> "*A* (The) test coil surrounds the middle portion of each bundle of test material. Four other test coils *each* of half the number of turns are placed over the *four positions of the* test material, approximately midway between the yokes and the center. The two center test coils are joined in series and the four end test coils are joined in series. The corresponding ballistic deflections, due to these two *sets of* test coils, are measures of the magnetic fluxes through the underlying portions of the magnetic circuit. By connecting the two test coils so that the induced electromotive force(s) opposes *that of the four coils* (each other), and adjusting the current through the compensating magnetizing coils so that there is no resulting ballistic deflection, an approximate uniformity of flux is secured through the greater portion of the test material, and the induction may be measured ballistically in the regular manner. The magnetizing force when the flux is adjusted to uniformity is that calculated from the uniform winding of the main magnetizing solenoids.

Appended to this report are the following tables of equivalents, which the committee recommends be published in the Proceedings as desirable information:

Table I.—Gausses to Ampere-Turns per Inch.
Table II.—Kilogausses to Kilolines per Square Inch.
Table III.—Watts per Kilogram to Watts per Pound.

This report has been submitted to letter ballot of the committee, which consists of 12 members, of whom 11 have voted affirmatively, none negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

C. W. BURROWS,
Chairman.

EDITORIAL NOTE.

The proposed Tentative Revisions of the Standard referred to in this report were accepted for publication and appear on pages 580–582.

APPENDIX.

TABLES OF EQUIVALENTS.

TABLE I.—GAUSSES TO AMPERE-TURNS PER INCH.

Gausses.	Ampere-Turns per Inch.									
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.00	0.20	0.40	0.61	0.81	1.01	1.21	1.41	1.62	1.82
1	2.02	2.22	2.43	2.63	2.83	3.03	3.23	3.44	3.64	3.84
2	4.04	4.24	4.45	4.65	4.85	5.05	5.26	5.46	5.66	5.86
3	6.06	6.27	6.47	6.67	6.87	7.07	7.28	7.48	7.68	7.88
4	8.09	8.29	8.49	8.69	8.89	9.10	9.30	9.50	9.70	9.90
5	10.11	10.31	10.51	10.71	10.91	11.12	11.32	11.52	11.72	11.93
6	12.13	12.33	12.53	12.73	12.94	13.14	13.34	13.54	13.74	13.95
7	14.15	14.35	14.55	14.76	14.96	15.16	15.36	15.56	15.77	15.97
8	16.17	16.37	16.57	16.78	16.98	17.18	17.38	17.59	17.79	17.99
9	18.19	18.39	18.60	18.80	19.00	19.20	19.40	19.61	19.81	20.01
10	20.21	20.41	20.62	20.82	21.02	21.22	21.43	21.63	21.83	22.03
11	22.23	22.44	22.64	22.84	23.04	23.34	23.45	23.65	23.85	24.05
12	24.26	24.46	24.66	24.86	25.06	25.27	25.47	25.67	25.87	26.07
13	26.28	26.48	26.68	26.88	27.09	27.29	27.49	27.69	27.89	28.10
14	28.30	28.50	28.70	28.90	29.11	29.31	29.51	29.71	29.91	30.12
15	30.32	30.52	30.72	30.93	31.13	31.33	31.53	31.73	31.94	32.14
16	32.34	32.54	32.74	32.95	33.15	33.35	33.55	33.76	33.96	34.16
17	34.36	34.56	34.77	34.97	35.17	35.37	35.57	35.78	35.98	36.18
18	36.38	36.59	36.79	36.99	37.19	37.39	37.60	37.80	38.00	38.20
19	38.40	38.61	38.81	39.01	39.21	39.41	39.62	39.82	40.02	40.22
20	40.43	40.63	40.83	41.03	41.23	41.44	41.64	41.84	42.04	42.24
21	42.45	42.65	42.85	43.05	43.26	43.46	43.66	43.86	44.06	44.27
22	44.47	44.67	44.87	45.07	45.28	45.48	45.68	45.88	46.09	46.29
23	46.49	46.69	46.89	47.10	47.30	47.50	47.70	47.90	48.11	48.31
24	48.51	48.71	48.91	49.12	49.32	49.52	49.72	49.93	50.13	50.33
25	50.53	50.73	50.94	51.14	51.34	51.54	51.74	51.95	52.15	52.35
26	52.55	52.76	52.96	53.16	53.36	53.56	53.77	53.97	54.17	54.37
27	54.57	54.78	54.98	55.18	55.38	55.58	55.79	55.99	56.19	56.39
28	56.60	56.80	57.00	57.20	57.40	57.61	57.81	58.01	58.21	58.41
29	58.62	58.82	59.02	59.22	59.43	59.63	59.83	60.03	60.23	60.44
30	60.64	60.84	61.04	61.24	61.45	61.65	61.85	62.05	62.26	62.46

TABLE II.—KILOGAUSSES TO KILOLINES PER SQUARE INCH.

Kilo-Gausses.	Kilolines per Square Inch.									
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.0	0.6	1.3	1.9	2.6	3.2	3.9	4.5	5.2	5.8
1	6.5	7.1	7.7	8.4	9.0	9.7	10.3	11.0	11.6	12.3
2	12.9	13.5	14.2	14.8	15.5	16.1	16.8	17.4	18.1	18.7
3	19.4	20.0	20.6	21.3	21.9	22.6	23.2	23.9	24.5	25.2
4	25.8	26.5	27.1	27.7	28.4	29.0	29.7	30.3	31.0	31.6
5	32.3	32.9	33.5	34.2	34.8	35.5	36.1	36.8	37.4	38.1
6	38.7	39.4	40.0	40.6	41.3	41.9	42.6	43.2	43.9	44.5
7	45.2	45.8	46.5	47.1	47.7	48.4	49.0	49.7	50.3	51.0
8	51.6	52.3	52.9	53.5	54.2	54.8	55.5	56.1	56.8	57.4
9	58.1	58.7	59.4	60.0	60.6	61.3	61.9	62.6	63.2	63.9
10	64.5	65.2	65.8	66.5	67.1	67.7	68.4	69.0	69.7	70.3
11	71.0	71.6	72.3	72.9	73.5	74.2	74.8	75.5	76.1	76.8
12	77.4	78.1	78.7	79.4	80.0	80.6	81.3	81.9	82.6	83.2
13	83.9	84.5	85.2	85.8	86.5	87.1	87.7	88.4	89.0	89.7
14	90.3	91.0	91.6	92.3	92.9	93.5	94.2	94.8	95.5	96.1
15	96.8	97.4	98.1	98.7	99.4	100.0	100.6	101.3	101.9	102.6
16	103.2	103.9	104.5	105.2	105.8	106.5	107.1	107.7	108.4	109.0
17	109.7	110.3	111.0	111.6	112.3	112.9	113.5	114.2	114.8	115.5
18	116.1	116.8	117.4	118.1	118.7	119.4	120.0	120.6	121.3	121.9
19	122.6	123.2	123.9	124.5	125.2	125.8	126.5	127.1	127.7	128.4
20	129.0	129.7	130.3	131.0	131.6	132.3	132.9	133.5	134.2	134.8
21	135.5	136.1	136.8	137.4	138.1	138.7	139.4	140.0	140.6	141.3
22	141.9	142.6	143.2	143.9	144.5	145.2	145.8	146.5	147.1	147.7
23	148.4	149.0	149.7	150.3	151.0	151.6	152.3	152.9	153.5	154.2
24	154.8	155.5	156.1	156.8	157.4	158.1	158.7	159.4	160.0	160.6
25	161.3	161.9	162.6	163.2	163.9	164.5	165.2	165.8	166.5	167.1
26	167.7	168.4	169.0	169.7	170.3	171.0	171.6	172.3	172.9	173.5
27	174.2	174.8	175.5	176.1	176.8	177.4	178.1	178.7	179.4	180.0
28	180.6	181.3	181.9	182.6	183.2	183.9	184.5	185.2	185.8	186.5
29	187.1	187.7	188.4	189.0	189.7	190.3	191.0	191.6	192.3	192.9
30	193.5	194.2	194.8	195.5	196.1	196.8	197.4	198.1	198.7	199.4

TABLE III.—WATTS PER KILOGRAM TO WATTS PER POUND.

Watts per Kilogram.	Watts per Pound									
	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.000	0.005	0.009	0.014	0.018	0.023	0.027	0.032	0.036	0.041
0.1	0.045	0.050	0.054	0.059	0.064	0.068	0.073	0.077	0.082	0.086
0.2	0.091	0.095	0.100	0.104	0.109	0.113	0.118	0.122	0.127	0.132
0.3	0.136	0.141	0.145	0.150	0.154	0.159	0.163	0.168	0.172	0.177
0.4	0.181	0.186	0.191	0.195	0.200	0.204	0.209	0.213	0.218	0.222
0.5	0.227	0.231	0.236	0.240	0.245	0.249	0.254	0.259	0.263	0.268
0.6	0.272	0.277	0.281	0.286	0.290	0.295	0.299	0.304	0.308	0.313
0.7	0.318	0.322	0.327	0.331	0.336	0.340	0.345	0.349	0.354	0.358
0.8	0.363	0.367	0.372	0.376	0.381	0.386	0.390	0.395	0.399	0.404
0.9	0.408	0.413	0.417	0.422	0.426	0.431	0.435	0.440	0.445	0.449
1.0	0.454	0.458	0.463	0.467	0.472	0.476	0.481	0.485	0.490	0.494
1.1	0.499	0.503	0.508	0.513	0.517	0.522	0.526	0.531	0.535	0.540
1.2	0.544	0.549	0.553	0.558	0.562	0.567	0.572	0.576	0.581	0.585
1.3	0.590	0.594	0.599	0.603	0.608	0.612	0.617	0.621	0.626	0.630
1.4	0.635	0.640	0.644	0.649	0.653	0.658	0.662	0.667	0.671	0.676
1.5	0.680	0.685	0.689	0.694	0.699	0.703	0.708	0.712	0.717	0.721
1.6	0.726	0.730	0.735	0.739	0.744	0.748	0.753	0.757	0.762	0.767
1.7	0.771	0.776	0.780	0.785	0.789	0.794	0.798	0.803	0.807	0.812
1.8	0.816	0.821	0.826	0.830	0.835	0.839	0.844	0.848	0.853	0.857
1.9	0.862	0.866	0.871	0.875	0.880	0.885	0.889	0.894	0.898	0.903
2.0	0.907	0.912	0.916	0.921	0.925	0.930	0.934	0.939	0.943	0.948
2.1	0.953	0.957	0.962	0.966	0.971	0.975	0.980	0.984	0.989	0.993
2.2	0.998	1.002	1.007	1.012	1.016	1.021	1.025	1.030	1.034	1.039
2.3	1.043	1.048	1.052	1.057	1.061	1.066	1.070	1.075	1.080	1.084
2.4	1.089	1.093	1.098	1.102	1.107	1.111	1.116	1.120	1.125	1.129
2.5	1.134	1.139	1.143	1.148	1.152	1.157	1.161	1.166	1.170	1.175
2.6	1.179	1.184	1.188	1.193	1.197	1.202	1.207	1.211	1.216	1.220
2.7	1.225	1.229	1.234	1.238	1.243	1.247	1.252	1.256	1.261	1.266
2.8	1.270	1.275	1.279	1.284	1.288	1.293	1.297	1.302	1.306	1.311
2.9	1.315	1.320	1.324	1.329	1.334	1.338	1.343	1.347	1.352	1.356
3.0	1.361	1.365	1.370	1.374	1.379	1.383	1.383	1.393	1.397	1.402
3.1	1.406	1.411	1.415	1.420	1.424	1.429	1.433	1.438	1.442	1.447
3.2	1.451	1.456	1.461	1.465	1.470	1.474	1.479	1.483	1.488	1.492
3.3	1.497	1.501	1.506	1.510	1.515	1.520	1.524	1.529	1.533	1.538
3.4	1.542	1.547	1.551	1.556	1.560	1.565	1.569	1.574	1.579	1.583
3.5	1.588	1.592	1.597	1.601	1.606	1.610	1.615	1.619	1.624	1.628
3.6	1.633	1.637	1.642	1.647	1.651	1.656	1.660	1.665	1.669	1.674
3.7	1.678	1.683	1.687	1.692	1.696	1.701	1.706	1.710	1.715	1.719
3.8	1.724	1.728	1.733	1.737	1.742	1.746	1.751	1.755	1.760	1.764
3.9	1.769	1.774	1.778	1.783	1.787	1.792	1.796	1.801	1.805	1.810
4.0	1.814	1.819	1.823	1.828	1.833	1.837	1.842	1.846	1.851	1.855
4.1	1.860	1.864	1.869	1.873	1.878	1.882	1.887	1.891	1.896	1.901
4.2	1.905	1.910	1.914	1.919	1.923	1.928	1.932	1.937	1.941	1.946
4.3	1.950	1.955	1.960	1.964	1.969	1.973	1.978	1.982	1.987	1.991
4.4	1.996	2.000	2.005	2.009	2.014	2.018	2.023	2.028	2.032	2.037
4.5	2.041	2.046	2.050	2.055	2.059	2.064	2.068	2.073	2.077	2.082
4.6	2.087	2.091	2.096	2.100	2.105	2.109	2.114	2.118	2.123	2.127
4.7	2.132	2.136	2.141	2.145	2.150	2.155	2.159	2.164	2.168	2.173
4.8	2.177	2.182	2.186	2.191	2.195	2.200	2.204	2.209	2.214	2.218
4.9	2.223	2.227	2.232	2.236	2.241	2.245	2.250	2.254	2.259	2.263
5.0	2.268	2.272	2.277	2.282	2.286	2.291	2.295	2.300	2.304	2.309

REPORT OF COMMITTEE B-1

ON

COPPER WIRE.

At the last annual meeting, Committee B-1 presented two tentative specifications, one for Bare Concentric-Lay Copper Cable and another for High-Strength Bronze Trolley Wire, which were printed in the 1915 Year-Book.[1] Announcement was also made of work started on the preparation of specifications for tinned copper wire and for extra-flexible copper cable.

The work on tinned copper wire has been carried on extensively and has proved more of a task than was at first anticipated. The formulation of tests to determine the thickness of the tin coat is not easy. Several methods of test are in more or less common use, but none of them is entirely satisfactory; hence certain members of the committee have taken the matter in hand and we are glad to be able to report that success appears to be in sight, and that probably next year this matter may be covered by a formal report.

A sub-committee of Committee B-1 has continued conferences with a sub-committee from the Standards Committee of the American Institute of Electrical Engineers, on the question of extra-flexible copper cable, but the existing ideas with respect to this product are so many and so varied that progress is necessarily slow. No report, save this bare mention of the difficulties encountered, is yet possible.

The same sub-committees have continued consideration of the Tentative Specifications for Bare Concentric-Lay Copper Cable,[2] and agreement has now been reached so that these tentative specifications, with the minor amendments noted later, are offered for adoption as standard. The Standards Committee of the American Institute of Electrical Engineers has adopted certain revisions of Table XII in Section 653 of the Standardization Rules, Edition of July 1, 1915, and in future the stranding of Classes A and B will agree with the standard stranding of the same classes of concentric-lay cable required in our specifications.

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[1] Pp. 541 and 546.

[2] 1915 Year-Book, p. 541.

No unfavorable criticisms of the Tentative Specifications for High-Strength Bronze Trolley Wire[1] have been received, and the committee has no modifications to make. These specifications are therefore offered for adoption as standard.

Attention is called to the statements in the explanatory notes accompanying the Standard Specifications for Hard-Drawn Copper Wire (Serial Designation: B 1–15), for Medium Hard-Drawn Copper Wire (Serial Designation: B 2–15), and for Soft or Annealed Copper Wire (Serial Designation: B 3–15)[2] that the adoption of a standard for the resistivity of copper corresponding to 100-per-cent conductivity is probable. This standard has been adopted and Committee B-1 has therefore modified these statements to bring them up to date. We have reported these changes to the Secretary-Treasurer for inclusion in the 1916 Year-Book, but since they in no wise affect the specifications themselves, the committee has felt that the change in the notes may be made without reference to the Society for letter ballot, and without change in the date of the specifications. A recommendation to this effect has been approved by the Executive Committee of the Society.

Committee B-1 recommends the following amendments in the Tentative Specifications for Bare Concentric-Lay Copper Cable: Hard, Medium-Hard, or Soft (1915 Year-Book, pages 541–545):

1. In Section 1 (*b*), strike out

> "*Class A*, for bare and weatherproof cable,"

and substitute the following:

> "*Class A*, for bare, weatherproof, slow-burning, and slow-burning weatherproof cable for aerial use."

2. In Table I, Class A, sizes 4/0 and 3/0, replace the present values for "Number of Wires" and "Diameter of Wires" (shown in Roman type below) by the values in italics:

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[1] 1915 Year-Book, p. 546.

[2] 1915 Year-Book, pp. 316, 325 and 332.

Size.	Number of Wires.		Diameter of Wires, mils.	
	Present.	Proposed.	Present.	Proposed.
4/0	7	*7-19*	173.9	*173.9-105.5*
3/0	7	*7-19*	155.0	*155.0- 94.0*

3. Add the following foot-note to Table I:

> "Note.—Class A cable, sizes 4/0 and 3/0, is usually 7-strand when bare and 19-strand when weatherproof, etc."

In conclusion, Committee B-1 offers the Tentative Specifications for Bare Concentric-Lay Cable: Hard, Medium-Hard, or Soft, in their proposed amended form, and the Tentative Specifications for High-Strength Bronze Trolley Wire, Round and Grooved: 40 and 65-per-cent Conductivity, for adoption as standard.

This report has been submitted to letter ballot of the committee, which consists of 10 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

J. A. Capp,
Chairman.

Editorial Note.

The proposed Standards referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appear in the 1916 Volume of A.S.T.M. Standards.

REPORT OF COMMITTEE B-2

ON

NON-FERROUS METALS AND ALLOYS.

The work of Committee B-2 has been enlarged by the formation of two new sub-committees, as follows:

V . . On Plates, Tubes and Staybolts for Locomotives,
W. Reuben Webster, *Chairman.*
VI . . On Non-Ferrous Alloys for Railroad Equipment,
Mr. G. H. Clamer, *Chairman.*

At the meeting of the committee held in April, the reports from the six sub-committees were presented and discussed.

Sub-Committee I on Pure Metals in Ingot Form.—The report of Sub-Committee I was presented by Mr. W. H. Bassett, chairman. It comprised a revision of the present Standard Specifications for Spelter (B 6-14)[1], which was accepted and referred to letter ballot of the committee. These proposed revisions are appended to this report.[2] They consist essentially in the addition of a fifth grade of spelter and a revision of the methods of sampling and analysis, which latter is based on the Report of the Sub-Committee on Methods of Analysis of Non-Ferrous Alloys of the Division of Industrial Chemists and Chemical Engineers of the American Chemical Society, approved by the Supervisory Committee on Standard Methods of Analysis of that Society. It is recommended that they be referred this year to letter ballot of the Society for adoption as standard.[2] Owing to the abnormal conditions at present prevailing it was thought that a short review of the spelter situation would be of timely interest, and this is presented in Appendix I. Similarly, owing to market conditions, it has been found impossible to formulate specifications for tin at the present time, and a review of the tin situation is offered in Appendix II.

Sub-Committee II on Wrought Metals and Alloys.—Mr. Webster, chairman, reported progress for Sub-Committee II, pointing out the difficulties under which they were laboring, due to the fact that the consumers specified certain properties for certain uses which could not be correlated satisfactorily.

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[1] 1915 Year-Book, p. 344.

[2] These revisions were changed to tentative by action at the annual meeting, and appear on pp. 583–589.—Ed.

Sub-Committee III on Sand-Cast Metals and Alloys.—Mr. W. M. Corse, chairman, reported that the sub-committee has been collecting data on various type alloys, and will be glad to receive information or data from members of the Society. The relation between elastic limit and yield point is of extreme interest; also the behavior under compression. In Appendix III will be found a brief discussion of the difficulties of issuing figures on sand-cast alloys.

Sub-Committee IV on White Metals.—Mr. G. H. Clamer, chairman, reported that the statements made above apply also to Sub-Committee IV. Attention is called to the work being carried on at the Bureau of Standards, and by the Committee of the American Chemical Society on Standard Methods of Analysis and Sampling.

Sub-Committee V on Plates, Tubes and Staybolts for Locomotives.—Mr. W. Reuben Webster, chairman, submitted the following proposed tentative specifications on behalf of the sub-committee:

1. For Copper Plates for Locomotive Fireboxes.
2. For Copper Bars for Locomotive Staybolts.
3. For Seamless Copper Boiler Tubes.
4. For Seamless Brass Boiler Tubes.

These specifications, which are appended to this report,[1] were approved for presentation to the Society and referred to letter ballot of the committee.

Sub-Committee VI on Non-Ferrous Alloys for Railroad Equipment.—Mr. G. H. Clamer presented the report of the sub-committee and pointed out that it had only recently been formed, and therefore its work had been done in the shortest of time. The proposed Tentative Specifications for Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings and Finished Car and Tender Bearings, appended to this report, were approved and referred to letter ballot of the committee.[2]

In conclusion, the committee again requests any suggestions or information from members of the Society that will in any way help them in their work.

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[1] These specifications appear on pp. 437–451.—Ed.

[2] These specifications were referred back to the committee, and have not been printed in the Proceedings.—Ed.

The analysis of the returns from the letter ballot is as follows:

Title.	Affirmative.	Negative.	Not Voting.
1. Revision in Standard Specifications for Spelter	36	0	8
PROPOSED TENTATIVE SPECIFICATIONS.			
2. For Copper Plates for Locomotive Fireboxes	34	0	10
3. For Copper Bars for Locomotive Staybolts	34	0	10
4. For Seamless Copper Boiler Tubes	34	0	10
5. For Seamless Brass Boiler Tubes	34	0	10
6. For Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings and Finished Car and Tender Bearings	35	2	7

This report has been submitted to letter ballot of the committee, which consists of 44 members, of whom 37 have voted affirmatively, none negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

WILLIAM CAMPBELL,
Chairman.

EDITORIAL NOTE.

The proposed revisions of the Standard Specifications for Spelter referred to in this report were changed to tentative revisions by action at the annual meeting (see pages 24-25), and appear on pages 583–589.

The proposed Tentative Specifications for Non-Ferrous Alloys for Railroad Equipment, etc., were referred back to the committee (see pages 25 and 193-199), and are not printed in the Proceedings. The remaining four proposed Tentative Standards referred to in the report were accepted for publication and appear on pages 437–451.

On the recommendation of the committee, the Tentative Specifications for the Alloy: Copper, 88 per cent; Tin, 10 per cent; Zinc, 2 per cent, as published in the 1915 Year-Book, were continued as tentative and appear on pages 434-436.

For Discussion on the report, see page 193.

APPENDIX I.

SPELTER: ITS GRADES AND USES.

Spelter, like all commercial metal, contains impurities, but, unlike most other metals, none of these impurities are advantageous for any of the purposes for which it is used. The effects of these impurities on different products made from it vary greatly, hence the necessity for several grades differing in purity.

Spelter is used for the following purposes, in quantities in the order mentioned: galvanizing, alloys, rolling, ornamental castings, and miscellaneous uses.

For ordinary galvanizing the effect of the common impurities is not very great. Iron is objectionable as causing a loss in dross and in making the coating more brittle and liable to crack and peel off. Lead, up to the limit found in commercial spelter, has no serious effect, but is objectionable when present in large quantity as it liquates in the bath and does not enter the coating and is, therefore, wasted. Lead is usually worth less than zinc and the purchaser does not wish to pay for it at zinc prices.

The four higher grades of spelter are chiefly used for alloys and the specifications were principally made for the alloy makers and do not, in all cases, call for metal suitable for some of the other purposes for which it is used.

Aluminum.—In alloys, aluminum is frequently very injurious, 0.01 per cent in many cases making brass useless for the purposes for which it is intended. In the few instances where its presence is desired, it is more satisfactory to add it directly than as a constituent of the spelter. The specifications,[1] therefore, require that the four higher grades of spelter shall be entirely free from aluminum.

Iron.—Iron is always present in spelter, but is very undesirable in brass and similar alloys, making them harder and greatly increasing the hardness due to cold working. The increased hardness is very objectionable, causing a greater consumption of power and endangering the rolling mills and drawing presses.

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[1] "Standard Specifications for Spelter," 1916 Volume of A.S.T.M. Standards, p. 423.

Lead.—Lead is very objectionable in some alloys and essential in others, and the main variation in the different grades of spelter is in the allowable amount of lead. High-grade spelter, which is used for alloys that are to be subjected to the most severe spinning and drawing operations, can be rejected if it contains over 0.07 per cent of lead, as lead reduces the ductility of brass.

Intermediate spelter, with a lead limit of 0.20 per cent is used for alloys that do not have to undergo as severe treatment, and also very largely for alloys like manganese bronze that are used both cast and wrought.

Brass special has a lead limit of 0.60 per cent, and is mainly used for brasses where the maximum ductility is not required. The lead and iron are limited to 0.60 per cent and 0.03 per cent respectively, because brass made from such spelter is used for ordinary drawing, spinning and forming work where the requirements are not especially severe.

Selected spelter carrying the maximum 0.80 per cent of lead and 0.04 per cent iron is used by brass manufacturers for making alloys to which lead is added in order to secure free cutting qualities. Material of this kind is usually made into rods and heavy sheets for the manufacturing of small articles by turning, milling and drilling operations. Such brass must contain sufficient lead to reduce the strength of the material and cause the chips to break easily.

Owing to the fact that brass is usually made in crucibles in small quantities, uniformity in the spelter is of the greatest importance. As lead segregates badly, and more markedly the higher the proportion, the lead limit of the average sample is made low enough to allow for this tendency without injurious effect on the product. Even when the brass manufacturer adds lead, he does so in known amounts and thus obtains a uniform alloy from the different pots, which would not be possible if all the lead needed were contained in the spelter.

Cadmium.—There is very little doubt but that cadmium in zinc is very injurious for some of the purposes for which it is used, as it renders it harder and much more brittle. There is, however, considerable difference of opinion as to how far these undesirable properties persist in alloys made from zinc containing cadmium. The majority of the brass makers are of the opinion that the high temperature of the brass pots cause so much of the cadmium to volatilize that the residual amount has very little deleterious effect.

There is no doubt but that large amounts of cadmium, say 1 or 2 per cent, make brass hard and brittle. We have no reliable information at present showing the effect of small amounts of cadmium on the alloys, and the evidence on this point is extremely conflicting.

Cadmium, together with lead, seems to intensify the effect of the latter and also causes the brass to become more sensitive to the effect of overheating in the various annealing operations to which the wrought material is subjected.

Very little spelter is made containing as much cadmium as is allowed for intermediate and brass special and the specifications, therefore, put practically no limit on cadmium except for high grade. Whatever the facts may be for alloys, it is certain that the amounts of cadmium allowed by the specifications are much greater than are permissible for other purposes for which zinc is used. The question of cadmium in the better grades is complicated by the fact that until the last year and a half practically all the high-grade and most of the intermediate spelter was made by one company from ores that are free from cadmium. The alloy makers have, therefore, had no extended experience with the effect of cadmium in the better grades of spelter, and during the last eighteen months conditions have been so abnormal that it is difficult to draw conclusions.

High-grade spelter is very extensively used for galvanizing telegraph and telephone wires which are required to stand sharp bending when making the "lineman's splice;" as it has been found that if impure spelter is used, the coating cracks and peels off the joint. The only high-grade spelter that has been used for this purpose is entirely free from cadmium. Cadmium being the element most likely to cause this trouble, it is very doubtful whether metal containing as much as is allowed by the specifications (0.05 per cent) would be suitable for this purpose.

For rolling, cadmium causes such severe cracking that metal containing much of it is not economical; but as practically all the zinc rolling mills produce their own spelter, this matter is within their own control and the specifications do not affect them.

For ornamental castings no spelter described by the specifications would be satisfactory. The high-grade is all right as far as lead and iron are concerned, but with the maximum cadmium allowed, it would be impossible to make castings of many of the common shapes.

APPENDIX II.

A REVIEW OF THE TIN SITUATION.

A specification to be generally adopted must reasonably reconcile the inherently different points of view of producer and consumer. This requires a classification of the material which will allow the producer to market everything produced and the consumer to choose the grade suitable for his particular work, paying accordingly. It is obviously necessary to understand the situation from both sides when a specification is to be drawn up and this providing of a common ground is one of the chief functions of this Society.

In the case of tin this mutual understanding is wholly lacking at the present time, due chiefly to the great geographical distance between the points of production and consumption and the speculative basis on which tin is handled by a broker as a middleman. This brief review is offered after investigation by the committee instead of a formal specification because it is believed that a preliminary discussion is necessary before even the foundation of a specification can be laid.

Ores.—Practically speaking, there is but one ore of tin, cassiterite, which in some cases is almost pure stannic oxide. It occurs as "vein tin" in mineral lodes and as "stream tin" in alluvial deposits. Vein tin is generally associated with other minerals, while stream tin is much purer.

Geographical Distribution.—Tin is found in paying quantities in very few places. The relative importance of the sources may be judged by their approximate outputs, stated below in long tons of metallic tin per annum.

	Long Tons.
Straits	60 000
Bolivia	20 000
Banka and Billiton	17 000
Cornwall	5 000
Australia	4 000
China	4 000
South Africa	2 500
Miscellaneous	2 500
	115 000

The Straits tin comes from Penang, Singapore and Malacca, the two latter being towns on the Malay Peninsula and the former an island off the west coast and in English hands. Banka and Billiton are islands in the Dutch East Indies.

Metallurgy.—The metallurgy of tin is very simple in the case of the pure deposits. The ores, which run but a few tenths of a per cent in tin, are readily concentrated by ordinary wet methods to a 60 to 70-per-cent product, on account of the high specific gravity of cassiterite. The concentrate is smelted in a reverberatory furnace with coal as a reducing agent and the fluxes necessary to slag the remaining gangue. The resulting crude tin is then refined by liquating and drossing. As stannic oxide is difficult to reduce, the various impurities present are also reduced and largely collected in the crude tin from which they can be but imperfectly removed by liquation. The result is that the purity of the final product depends largely upon that of the original tinstone, so that certain deposits have come to have a reputation as producers of high-grade tin. At this writing electrolytically refined tin is just beginning to appear on the market in quantity from the treatment of foul bullion produced in the usual way from Bolivian concentrates. Electrolysis of course should obliterate the past history of the crude tin.

Market.—It has been the fixed policy of the Dutch and English colonies to smelt the tin concentrates at the point of production, export duties having been imposed on tin ores. Prior to the war, the Bolivian concentrates were sent to England and Germany, where they were worked into a low-grade tin. They are now coming chiefly to the United States and the crude tin obtained therefrom electrolytically refined as stated above. Up to this time it has been impossible to buy the desirable Straits and Banka products which make up the bulk of the high-grade output except upon reputation by brands, and the sales in America have been handled by brokers who are practically subject to the dictation of the Dutch-English ring controlling those brands, in spite of the fact that this country consumes 45,000 tons a year, or over a third of the world's production. The recent importation of Bolivian concentrates and their local treatment it is to be hoped will alter this situation.

According to the rules of the London Metal Exchange, tin is merchantable as Standard Tin only when the warrant is accompanied by analysis certifying that the metal contains either 99.00 or 99.75 per cent of pure tin, according to whether the quality is that of common tin or refined tin, and also that it is of the correct physical condition.

Straits, Australian, English Refined, Banka and Billiton fall within the highest class, namely, refined tin. The Chinese tins are "off-grade," carrying considerable lead, and the German tins resulting from the smelting of Bolivian concentrates are very foul. Off-grade tins are sold on the basis of a sliding scale for tin contents. The worst of them will run over 90 per cent tin while the high-grade tins will run 99.8 to 99.9 per cent. The only tests required for good merchantable tin aside from its origin are that it shall run at least 99.75 per cent tin and that a bar when nicked and bent double shall not crack.

TABLE I.—ANALYSES OF DIFFERENT BRANDS OF TIN.

ALL VALUES IN PER CENT.

Elements.	Electrolytic.[1]	Straits, Banka, Billiton.	Australian.	English Common.	English Refined.	German.	Chinese.	Bolivian.
Tin........	99.80-99.95	99.80-99.95	99.75-99.90	99.2	99.9	99+	95-99	93
Antimony.	....	0.02	0.04	0.25	0.04	0.65	0.02-0.40	4.0
Arsenic.....	...	0.04	0.06	0.06	0.05		0.06	0.2
Bismuth.....	....	none	0.003	0.06	0.001	...	0.01	0.1
Copper....	....	0.01	0.04	0.08	0.015		0.09	0.5
Iron.......	...	0.03	0.03	0.004	0.002	...	0.15	0.02
Lead.....	...	0.02	0.04	0.36	0.01	0.14	0.3-4.0	2.7
Zinc......	....	0.03	none	0.006	0.01	..	none	0.03

[1] Representative analyses of the new electrolytic tin are not available at this writing.

Analyses.—The consumer has generally met the situation in which he finds himself by buying a first-class brand, analyzing it when he gets it, and then sorting the lots by analysis for certain uses. It is of doubtful value to give here a long list of analyses of different brands, but a rough idea of the various grades given in Table I will illustrate the situation.

Uses.—The principal uses of tin, aside from tin salts and pigments, are as metal in pipe, fusible boiler plugs, etc.; as a coating, as in tin plate, tinned wire, tin-lead foil, etc.; and in an alloy, as in bronze, babbitt, solder, britannia metal, type metal, fusible alloys, etc. The bronzes are alloys with copper and zinc; babbitt metal with antimony and copper; solder with lead and a little antimony; britannia metal with antimony; fusible alloys with lead, bismuth and cadmium.

Allowable Impurities.—The impurities in tin may cause trouble by poisoning, as in the case of pipe and tin cans; by impairing fluidity, causing an excessive consumption of tin used for coating, or making solder hard to apply; by fouling an alloy and spoiling its appearance; by impairing the ductility of alloys which have to be worked, such as bronze or britannia metal; by causing local galvanic action and possibly "tin pest;" and by affecting the melting point of fusible alloys.

In a general way the purest obtainable tin is desired for pipe and boiler plugs. The U. S. Bureau of Standards has found that zinc, generally introduced by a foul pot when remelting tin, causes serious deterioration in boiler plugs and recommends as nearly as possible absolute freedom from zinc and lead.

One of the tin-plate manufacturers states that lead makes a mottled finish, iron causes rough surface and impairs fluidity, and arsenic and zinc tend to form poisonous salts. They suggest maximum allowable percentages as follows:

Lead	0.04	per cent
Copper	0.02	"
Iron	0.05	"
Arsenic	0.05	"
Antimony	0.02	"
Zinc	0.05	"

One of the manufacturers of wrought bronze gives the following maximum allowable percentages:

Antimony	0.01	per cent
Bismuth	0.001	"
Lead	0.05	"
Iron	0.05	"

APPENDIX III.

THE DIFFICULTY OF ISSUING FIGURES ON SAND-CAST ALLOYS.

In considering the subject of specifications for non-ferrous alloys a difficulty has arisen in securing sufficient reliable information from experience tables to enable Sub-Committee III on Sand-Cast Metals and Alloys to recommend specifications which would be authentic. A comparatively small amount of work has been done on non-ferrous alloys, and the need for information among engineers is very great, as shown by the almost continuous stream of inquiries that come to such places as the Bureau of Standards at Washington. The data from which replies could be made are very meager and not always reliable.

In order to improve conditions a suggestion was made that the committee publish such information as it had with the idea of adding to it from time to time. At the committee meeting at which this matter was discussed, it was deemed advisable, on account of the lack of sufficient experience tables, to defer the publication of such information until more data could be obtained. This action was prompted largely by the fact that many people refer to the Proceedings of the American Society for Testing Materials for fundamental data for preparing such specifications, and such people might assume that publication of information, such as mentioned above, was authentic, when it was really published to arouse interest in the subject and to stimulate the sending in of further results for checking purposes. The idea was to publish such information as was secured by the ordinary physical tests, such as ultimate tensile strength, proportional limit, elongation and reduction of area, which are not so difficult to obtain.

The main difficulty is in getting the exact history of the samples on which the tests are made. Variations in foundry practice cause variations as high as 25,000 lb. per sq. in. in alloys which have a maximum tensile strength of 50,000 lb. per sq. in. For example, in the 88-10-2 bronze results have been secured as high as 50,000 lb. per sq. in. on some samples and as low as 25,000 lb. per sq. in. on others.

The size and design of the casting also have a marked influence on the results, so that it is very difficult, indeed, to prepare either specifications or authentic information on the subject.

The committee's idea is to call attention to this fact and to urge work on the part of those interested that may add to our experience tables sufficiently to enable us to publish authentic data.

To the properties mentioned above might be added such properties as linear coefficient of expansion, electrical conductivity, thermal conductivity, specific gravity, weight per cubic inch, pattern maker's allowance for shrinkage, Brinell hardness, elastic limit or proportional limit under compression, and others that might be of special interest for certain work.

If any of our members could write papers as individuals bearing on this subject, giving information from their own tests, it would help the situation materially and it is hoped that they will bear this suggestion in mind when asked to prepare such papers for any technical society of which they are a member.

The committee also wishes to emphasize the importance of securing accurate tests from pieces cut from castings themselves, as this is really the information that the engineer desires. If buyers of castings will bear this point in mind the apparent discrepancy will gradually be cleared up as the publication of these results is increased. It is very seldom that extra castings are ordered for this purpose, but we do not see how authentic information regarding the properties of the metal actually in the casting can be obtained without such procedure.

The suggestion of using a standard shape test bar will certainly help a good deal, but even then there is always a question whether such a test bar represents a casting itself.

It is hoped that some of the difficulties underlying this whole subject have been brought out and that any suggestions that any of our members may have to make on the subject will be sent to the chairman of Committee B-2, so that Sub-Committee III, which is particularly interested in this subject, will be in position to prepare a report at some later date.

DISCUSSION.

Mr. G. K. Elliott (*presented in written form and read by the author*).—Viewed strictly from the standpoint of one intimately connected for many years with the manufacture of valves and other fittings for steam service of all kinds, the requirements for steam metal embodied in the proposed Tentative Specifications for Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings, and Finished Car and Tender Bearings, call for some remarks of a critical nature. **Mr. Elliott.**

Rigidly interpreted, the specifications proposed would admit some alloys which the informed valve manufacturer knows not to be good steam metal under the modern conditions of steam engineering; while at the same time, they would exclude or at least fail to take cognizance of many of the admittedly best steam alloys; striking examples of these last being the steam metals which are described in the official specifications of the United States Navy Department, namely "Valve Bronze or Composition M" and "Gun Metal or Composition G." The following is a copy of the official specifications for the composition of these two alloys, together with the composition recommended by Committee B-2:

Element.	Composition M, per cent.	Composition G, per cent.	Committee B-2, per cent.
Copper	87 (min.)	87–89	Remainder
Tin	7 (min.)	9–11	5–7
Lead	1.0 (max.)	0.2 (max.)	2–3.5
Zinc	Remainder	1–3	3–5
Iron	0.06 (max.)	0.06 (max.)	0.25 (max.)
Antimony	....	....	0.25 (max.)
Phosphorus	....	....	0.02 (max.)
Aluminum	....	....	None
Sulfur	....	....	0.05 (max.)
Total impurity, excluding zinc	....	....	.05

Mr. Elliott. Comparing these specifications with those proposed by the committee, we find that composition M has more tin and less lead than is specifically sanctioned by the proposed specifications, while composition G has more tin and less lead and zinc. Thus, we see, the only steam metals officially described as such in the printed specifications of the United States Navy Department would not be acceptable for steam valves for railroad use under a literal interpretation of the suggested specifications which are before us.

Taken item by item, our criticism of the proposed specifications for steam metal is as follows:

Tin.—This is the most valuable single addition which can be made to copper in forming a steam metal, because it endows the alloy with not only considerable strength, but also with the property of hardness, thereby enabling it to resist the wire-drawing tendency which steam has when flowing through a closely-throttled valve, as well as the erosive effect of rust and scale which to some extent are carried in the current passing through most steam valves in active service. The proposed minimum of 5 per cent should be acceptable to all makers and users of steam valves of the better grade; but why should the "permissible variation" for tin be held under 7 per cent? As we already have pointed out, this maximum would eliminate the steam metals used by the Navy Department, and, in fact, all the best grades which are being incorporated into the high-duty valves of to-day. If a maximum has to be fixed it is our suggestion that it be made somewhere around 12 per cent, which practically and economically is close to the limit owing to the fact that the cost of machining bronze castings increases greatly as the content of tin is increased.

Lead.—This is a most important element in the consideration of steam metals, because if carelessly used it may give the alloy some of the qualities which are least desired. A bronze will hold safely only a comparatively small amount of lead and any excess over the limit is liable to cause a condition akin to rottenness at the temperature of steam. Also, in excess, lead has been known to cause soft spots which are easily eroded, becoming nuclei for pits upon the seating surfaces of a valve. In our estimation 3.5 per cent is too high a maximum for the lead in a good steam metal, and our suggestion would be to **Mr. Elliott.** specify that the lead be not over 2 per cent, which experience has demonstrated to be a safe and not too conservative upper limit.

Zinc.—The proposal of 3 to 5 per cent for this element we can criticize but mildly. It would be well, however, to do away with the lower limit, because a strict adherence to it would rule out many excellent steam metals, including compositions M and G of the Navy Department. Some of the best steam alloys we know of contain absolutely no zinc.

Iron.—It is not positively known that small quantities of this element have any particularly bad effect upon steam metal, but so much as 0.25 per cent "looks bad" for the reason that it is suggestive of a free, if not an exclusive use of scrap metals. The standard navy specifications do not allow over 0.06 per cent of iron in steam metals M and G.

Antimony.—The effect upon steam metal of a small amount of this element is problematical, but its presence to the extent of 0.25 per cent is generally accepted as rather conclusive evidence of the use of large quantities of scrap metal. In fact, without going into any consideration of the relative merits of steam metal made from virgin metals as against that made from scrap metals, we can say that if there is any intention on the part of the committee to eliminate the use of scrap metals in making up steam fittings according to the specifications they have formulated, the antimony specification is sufficiently high to make any such intention ineffective. The same also may be said about the sulfur specification.

Aluminum.—Concerning aluminum, the committee is acting correctly in trying to forbid absolutely its presence.

MR. S. V. HUNNINGS.—I shall not discuss the merits of the **Mr. Hunning** different compositions, but I want to say that I can recall but one or two American railroads that have specifications covering steam metal, red brass and yellow brass, or a brazing metal, in purchasing locomotives. To include these metals in these specifications, would mean that our field of inspection in that line of material would be broadened at least 50 per cent, and in most cases for parts of minor importance. I feel that it would be a serious mistake, in view of the fact that few if any

Mr. Hunnings. of the American roads have specifications for these four materials, to include them in even a tentative specification. If, in the course of years, there should be a demand for such specifications shown by the issuing of specifications for these materials by railroads, let us then have such specifications; but let us not wish them on the locomotive builder at this time when there is absolutely no demand for them.

Mr. Elliott. MR. ELLIOTT.—Regarding the advisability or the inadvisability of including a steam metal alloy in our specifications, I should like to express the belief that as a result of the great advances of modern steam engineering in the direction of higher pressures and temperatures, the subject of the proper alloys for steam valves and fittings is becoming more and more important in proportion. For instance, The Interstate Commerce Commission has begun to take an interest in the subject of steam valves for railroad locomotive use, as is shown in a recent ruling concerning the weight of such valves. From this phase of the question to that of the physical and chemical properties of the steam alloys going into these valves is only a very short step; in fact it would seem to be a necessary step, for it would be far from illogical to base the required weight of a valve upon the quality of the alloy.

Mr. Smith. MR. H. E. SMITH.—I can confirm what Mr. Hunnings says in regard to some of the alloys being of small use in railroad equipment. There are not very many specifications for such alloys in active use. I am a member of the sub-committee that formulated these specifications and I voted for this table as being possible for the uses intended in railroad service; but just how to reach the end Mr. Hunnings desires is a little doubtful. We have a good many specifications and not all of them are needed by all purchasers. I think the proposed specifications would be useful, but if there is any way in which it could be indicated that they are not necessary for the purchase of small and unimportant parts, I think that might be a good thing to do. So far as the mixtures are concerned, I think every member of the committee realizes the difficulty of formulating percentages when there are so many constituents, and the possible combinations are almost limitless. This appears especially true in the babbitt specifications where, had we put in all the compositions desired by various members of the sub-committee, the table would have occupied a good deal of space. There would undoubtedly be various special mixtures not covered by any table that we could devise. **Mr. Smith.**

MR. HUNNINGS.—If I may speak again in answer to Mr. Smith's reasoning that it might be possible to have on record, among the standards of the Society, specifications covering steam metal, red brass, yellow brass and brazing metal, I think that, if it is thought desirable to have specifications for other uses than locomotive work, the committee could be instructed to prepare such general specifications. **Mr. Hunnings.**

THE CHAIRMAN (PRESIDENT MANSFIELD MERRIMAN).—Are there any further remarks? If not, I will put the motion that the proposed Tentative Specifications for Non-Ferrous Alloys for Railroad Equipment in Ingots, Castings and Finished Car and Tender Bearings be accepted and printed. **The Chairman.**

MR. HUNNINGS.—I move to amend the motion to eliminate from the specifications all reference to red brass, yellow brass, steam metal and brazing metal. **Mr. Hunnings.**

[This amendment was lost.]

MR. HUNNINGS.—I should like to call attention to the fact that the railway and locomotive representatives, the interests affected by these specifications, are voting unanimously against the adoption of the specifications. It seems hardly fair that we should be outvoted by non-affected interests. **Mr. Hunnings.**

THE CHAIRMAN.—There were five votes in the affirmative and eleven in the negative. The amendment therefore was not carried. The original motion will now be taken up, that these proposed tentative specifications be accepted and printed. **The Chairman.**

[This motion was carried.]

MR. JESSE L. JONES.—Mr. Chairman, I move that we reconsider our action in regard to these specifications and refer them back to the committee. I am a member of Committee B-2, but did not have the opportunity of attending the meeting at which these specifications were considered. While they are very creditable, there are a number of points, some of which have been mentioned this morning, which seem open to objection. If the committee should consider these points, it might no doubt modify the specifications so that they will be more **Mr. Jones.**

Mr. Jones. acceptable. For instance, the requirements for babbitt metal and lining metal are so similar that when we consider the maximum for tin and antimony in one case and the minimum in the other, it is possible to have two alloys that would meet the requirements for composition but which would show very little difference in physical characteristics.

Also, some of the railroads use an alloy of 87 per cent lead and 13 per cent antimony for car bearings; and for high-speed service, that is, on the limited trains, an alloy of $83\frac{1}{3}$ per cent tin, $8\frac{1}{3}$ per cent antimony, and $8\frac{1}{3}$ per cent copper has been used. Possibly one or both of these alloys could be included in the specifications or substituted for one or the other of the proposed babbitts.

In talking with some of the members of the committee, doubt has been expressed as to the expediency of the limit for iron. A great many people regard 0.25 per cent as the maximum allowable for brass and bronze. In the specifications, 0.40 per cent is allowed. There are a number of other similar points that ought possibly to be taken into consideration before finally passing on the report of this committee.

I therefore move that the specifications be referred back to the committee for further consideration.

Mr. Corse. MR. W. M. CORSE.—At the meeting of Committee B-2 at which these specifications were considered, Sub-committee III on Sand-Cast Metals and Alloys, of which I happen to be chairman, presented certain specifications as tentative, which were referred back to the sub-committee, and I was asked to prepare a statement explaining the difficulties of preparing specifications for sand-cast alloys at the present time. This statement appears as Appendix III to the report of Committee B-2, and I believe that the difficulties there outlined apply in a certain degree to the specifications under discussion. I voted in favor of publishing these specifications as tentative, but I believe it would be better to refer them back to the committee, in order that our experience tables may be further amplified.

With reference to the iron content, Mr. Elliott stated that the Navy Department specifications call for a maximum of 0.06 per cent iron. Those are the printed specifications of the Navy Department, but they are not their actual working specifications; and that feature was considered by the committee in preparing the specifications before you. The Navy Department, especially during the last few years, have found that the iron content of some of their bronzes does not have to be as carefully regulated as the specifications would indicate, and we believe that when they are sufficiently established in their position with reference to impurities in these alloys, the Navy Department will then revise their specifications. The various navy yards, particularly at Washington, have been doing a large amount of valuable work on alloys, and the results with the use of scrap metal are often found to be far superior to those obtained from new metal, so that it is an open question whether we should limit our specifications so as to exclude scrap metal in all cases. **Mr. Corse.**

[Mr. Jones' motion was then carried.]

REPORT OF COMMITTEE C-1

ON

CEMENT.

Committee C-1 submits herewith, as appended to this report:

1. A revision of the requirements for Portland cement in the present Standard Specifications for Cement (C-1–09);[1]
2. Proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar.

The committee recommends that the proposed revised specifications for Portland cement be given the title "American Specifications and Methods of Tests for Portland Cement." In the judgment of the committee, they are entitled to this distinction because they are the result of several years' work of the special committees representing the Board of Direction of the American Society of Civil Engineers, the United States Government Departmental Committee, and Committee C-1. It is highly desirable to convey not only to those who use cement in this country, but also to our export trade, that there is a single uniform American specification for this important product.

These revised specifications, under the by-laws of the Society, would normally be printed for one year as tentative, and be submitted to letter ballot of the Society in 1917. It is understood that certain changes in the by-laws will be recommended by the Executive Committee at this annual meeting, by which the contents of the Year-Book will hereafter be printed biennially beginning 1916. In view of the fact that the specifications for Portland cement have not been revised since 1909, it would be undesirable in the judgment of the committee to postpone the publication of the revised specifications as a standard until 1918. On the other hand, it would be also undesirable to have these specifications become effective immediately, since that would not afford sufficient time for the adjustment of the cement mills to meet the increased requirements of these specifications, and in view of the fact that most contracts provide that the cement shall meet the requirements of the Specifications for Portland Cement of the American Society for Testing Materials, the committee recommends that these specifications be referred to letter ballot of the Society at once, with the understanding that if adopted they shall become effective January 1, 1917.

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[1] 1915 Year-Book, p. 350.

The committee further recommends that the proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar be received for publication as a tentative standard.

The results of the letter ballot of the committee on these two recommendations are as follows:

Title.	Affirmative.	Negative.	Not Voting.
1. Proposed Revised Specifications entitled "American Specifications and Methods of Tests for Portland Cement"..............................	56[a]	0	2
2. Proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar..............................	56	0	2

This report has been submitted to letter ballot of the committee, which consists of 58 members, of whom 56[b] have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

GEORGE F. SWAIN,
Chairman.

RICHARD L. HUMPHREY,
Secretary.

EDITORIAL NOTE.

For action taken at the annual meeting on the Report of Committee C-1, see "Summary of the Proceedings," pages 18-20. In presenting the report, the committee recommended extensive amendments in the proposed revised American Specifications and Methods of Tests for Portland Cement, which were approved. These amendments are not given here, as they were so extensive as to require the reprinting of the specifications in revised form.

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[a] Two vote "affirmatively" with a few amendments. One votes "affirmatively" provided the specifications are submitted to letter ballot after approval of the 1917 meeting.

[b] One votes "affirmatively" except as to effective date.

At a special meeting of the Executive Committee held August 7, 1916, it was decided to change the title of the proposed American Specifications and Methods of Tests for Portland Cement to read "Standard Specifications and Tests for Portland Cement."

At the quarterly meeting of the Executive Committee held October 10, 1916, the addition of the following note directly after the title of these specifications was approved:

> "These specifications are the result of several years' work of a special committee representing a United States Government Departmental Committee, the Board of Direction of the American Society of Civil Engineers, and Committee C-1 on Cement of the American Society for Testing Materials."

Since that meeting the addition of the phrase "in cooperation with Committee C-1" to that footnote, at the recommendation of Committee C-1, has been provisionally authorized by President Stevenson, subject to approval at the next quarterly meeting of the Executive Committee.

The Specifications and Tests, in the form as amended at the annual meeting, were adopted by letter ballot of the Society on September 1, 1916, with the understanding that they will not become effective till January 1, 1917. Several minor changes in form were subsequently made with the approval of the committee, and the Specifications and Tests in their final revised form appear in the 1916 Volume of A.S.T.M. Standards.

The proposed Tentative Specifications and Tests for Compressive Strength of Portland Cement Mortar were accepted for publication and appear on pages 590–593 as a tentative revision of the Standard Specifications and Tests for Portland Cement.

For Discussion on the report, see page 203.

DISCUSSION.

Mr. Howes.

MR. B. A. HOWES (*presented in written form and read by the Secretary*).—In 1887 M. H. Le Chatelier made a statement, which he again confirmed in 1903, of which the following is an authorized translation:

> The proportion of free lime necessary to alter in a notable manner the qualities of a cement is extremely slight. . . . I would be induced to believe that at least nine times in ten it (free lime) is the only cause of the disintegration of hydraulic mortars used in the air or in fresh water. If it escapes observation frequently, it is because its action often does not become sensible until the end of several months, that is, long after the end of the tests which are usually made at present.

During the past two years I have had under investigation several important structures exposed to air and fresh water only, which, although constructed under the most careful engineering supervision, passing standard test requirements, and rigid inspection at completion, and after completion appearing first class for the usual period of inspection, nevertheless developed serious disintegration after a period of from two to five years. My investigations of these cases confirm in a striking manner the observations of M. Le Chatelier.

Fig. 1 is a photograph of a canal wall in which poor workmanship and rich mixture accelerated the original defect of the cement (free lime). Where this concrete is kept damp and protected from running water it is hard and rings to the hammer blow like an anvil. At the water line and above it has crumbled as shown. In contact with running water the cement has dissolved completely, exposing the aggregate. The section in the foreground cast at a different time is progressing in the same way. Fig. 2 is a microphotograph of a specimen from this disintegrated section. It is full of voids and shows the progressive disintegration following the dissolving and carbonation of lime, which, where the concrete is protected from air and running water, remains as crystallin hydrate. Note the crack connecting two voids along which carbonation is progressing.

Mr. Howes. I therefore object to the new specifications, first as regularizing practices in cement manufacture which tend to conceal free lime from the standard tests, without providing methods or tests for its control.

The reference is in particular to the clause in the new specifications which explicitly allows the unlimited addition of water to cement after calcination. Dousing, the usual form of this addition, affects that portion of free lime that would naturally show up in the 7-day tests. There has been more or less discussion by manufacturers as to the effect of dousing and aging of clinker, and their general opinion is that it does no harm so far as the 28-day tests indicate; that it corrects the evils of free lime caused by coarse grinding of raw material, and reduces the cost of grinding the calcined clinker.

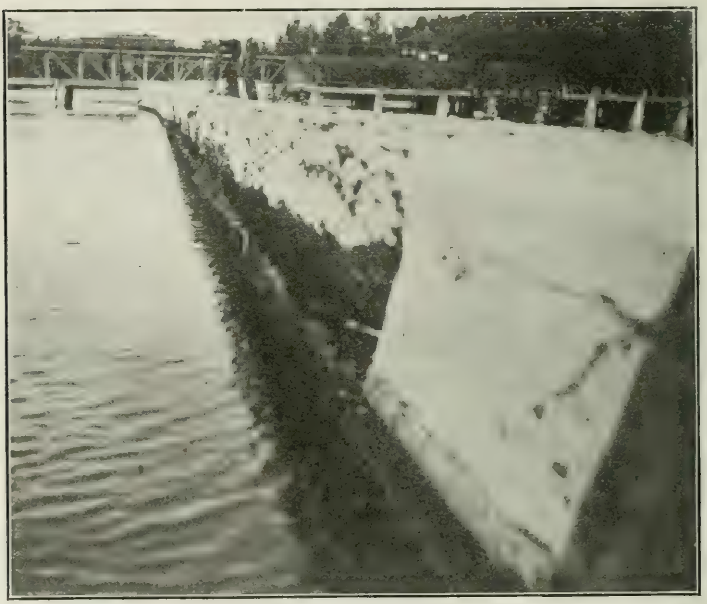

FIG. 1.

Now at present the acceptance tests are the 7-day tests, with some regard to the 28-day tests, and these test results are mainly a function of the aluminate content. But the long-time

Mr. Howes.

integrity of concrete is dependent on the tricalcium silicate content and on the elimination of free lime; while the presence of free lime after calcination is also an indicator of deficiency of tricalcium silicate.

With standard composition and a manufacturing method which will obscure the presence of free lime, such as dousing and aging of the clinker, we can by going through the motions of making Portland cement produce an aluminate or puzzolanic cement as distinguished from a true Portland or calcic-silicate cement which will pass the standard tests here proposed but will be very inferior in integrity where exposed to the elements.

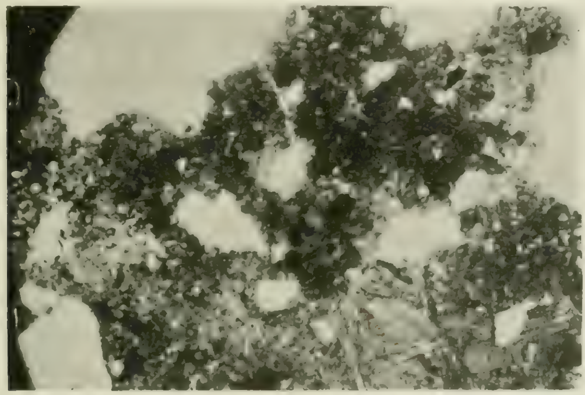

FIG. 2.—Microphotograph of Specimen from Fig. 1. (× 30).

There should be a means of control of the essential long-life constituents which it has been the tendency to disregard.

It seems that having run out of the market natural and puzzolanic cements on the ground of their undoubted inferiority, we should, with the acceptance of these specifications as they stand, without further control be opening wide the door to cements approaching the same type. The tendency of Portland cement users for the last ten years has been to an increasing suspicion of its enduring quality. It would seem that it is at least regrettable for the future confidence in cement structures that a mode of manufacture should be regularized that puts a premium on the possible undisclosed presence of free lime, the most dangerous possible ingredient.

Mr. Howes. For the above reasons I therefore also object to the methods of sampling which "provide" for composite samples instead of "allowing" averaging at the discretion of the engineer. The recommendations of the American Society of Civil Engineers on the uniform tests dated January 17, 1912, say "to determine the acceptance or rejection of cements it is preferable when time permits to test the samples separately." For careful work, individual samples should be so selected, as to indicate any weak spots in material used—whether from hourly runs into the bin, or from material as being shipped or received at the job.

Hence I also object to the expedition of the acceptance of these specifications as proposed. These changes should have a great deal more consideration and discussion in open meeting.

Mr. Humphrey. MR. RICHARD L. HUMPHREY (*Secretary of Committee C-1*).—I wish to refer to three points made by Mr. Howe. The first concerns the unlimited addition of water. You can not add unlimited water since this is controlled by the loss on ignition requirement. The second point is that the specifications provide for composite samples, whereas the amended specifications, as presented by the committee, allow both the individual and the composite sample. Third, the question of lime to which he refers is controlled by the requirements for tensile strength; so that there is nothing in this paper that need modify the action of the committee.

Mr. Ashton. MR. ERNEST ASHTON.—The author of this discussion refers to the probable or ultimate effect of tri-calcium silicate with regard to the value of cement in manufactured concrete. I wonder if he is aware of the fact that in order to carry out a microscopical examination of the kind that would determine the percentage of tri-calcium silicate, a petrographer would be needed. In all probability we could count upon the fingers of one hand the number of men in this country who could carry on an investigation of this kind. Therefore, to make this a part of the specifications at this time would seem rather absurd.

Mr. Kitts. MR. J. A. KITTS (*presented in written form and read in abstract by the Secretary*).—The writer questions the advisability of retaining the proportion of 1:3, by weight, for standard mortar.

Mr. Kitts. Before entering upon an argument why these proportions should be changed, it will be necessary to present definitions covering the terms necessary for a mathematical analysis.

The writer has recently used the term "Apparent Specific Gravity" in speaking of the weight per unit volume (metric) of an aggregate of cement, sand or rock.[1] This term will lead to confusion as it has been applied, in a different sense, to unit fragments of various substances.

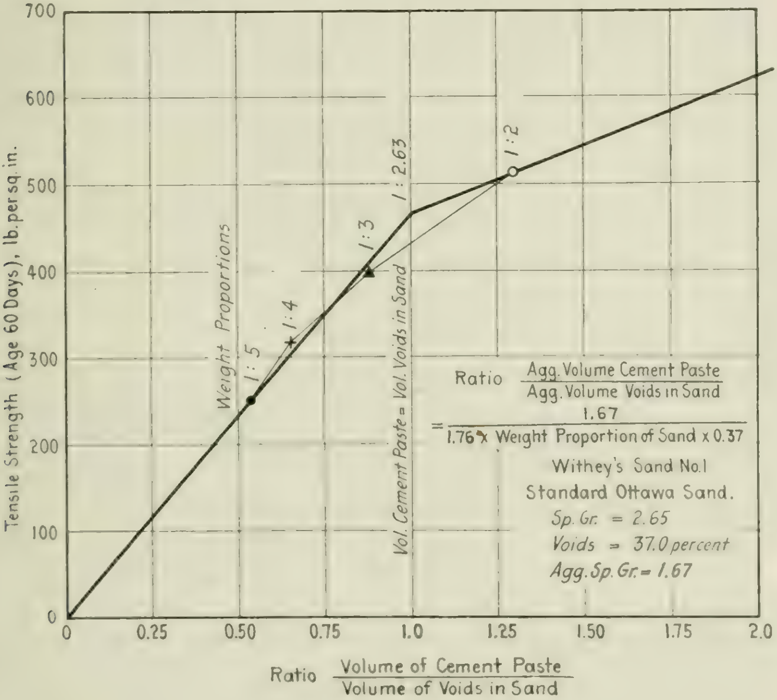

FIG. 3.

If we have a measure of sand, 1 cu. ft. for example, weighing 125 lb., the specific gravity of the superficial volume will be $125 \div 62.4 = 2.0$. We will call this the Aggregate Specific Gravity which is equal to Weight (g.) ÷ Aggregate Volume (cc.), and Aggregate Volume is equal to the true volume of the particles making up the aggregate plus the microscopical pores in the

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[1] "Weight-Volumetric Proportioning of Concrete Aggregates in Testing," J. A. Kitts, *oceedings*, Am. Soc. Test. Mats., Vol. XV, Part II, p. 153 (1915).

Mr. Kitts. particles plus the voids between the particles. For practical purposes, generally, the microscopic pores may be neglected.

The values in the argument following should be considered as approximate until verified by further tests.

1. If 110 lb. of dry cement makes 1 cu. ft. of cement paste of normal consistency, the Aggregate Specific Gravity of dry cement for this consistency is $110 \div 62.4 = 1.76$.

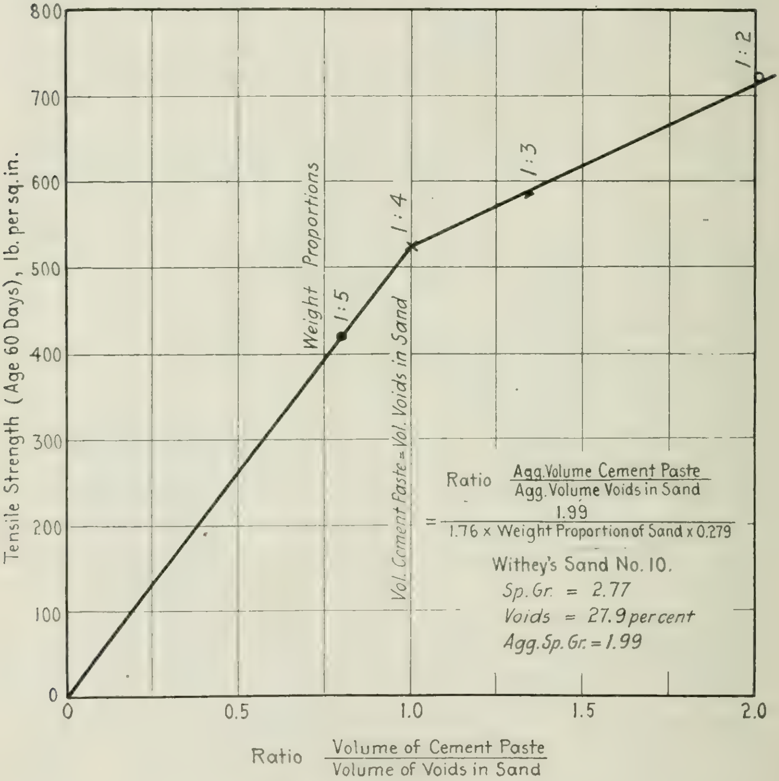

FIG. 4.

2. Standard Ottawa sand closely approximates the following characteristics: Specific Gravity, 2.65; Voids, 37 per cent; Aggregate Specific Gravity, 1.67.

$$\text{Agg. Sp. Gr.} = (1 - 0.37)\ 2.65 = 1.67.$$

3. The volumetric proportions corresponding to the 1:3 weight proportions, for standard Ottawa sand, are 1:3.18. **Mr. Kitts.**

$$\frac{\text{Agg. Volume Sand}}{\text{Agg. Volume Cement}} = \frac{3 \times \text{Agg. Sp. Gr. Cement}}{\text{Agg. Sp. Gr. Sand}} = \frac{3 \times 1.76}{1.67} = 3.18$$

$$= \frac{1}{3.18 \times 0.37} = 0.85$$

4. Standard mortar in 1:3 weight proportions has a ratio of volume of cement paste to volume of voids in the sand equal to 0.85, or, in other words, only 85 per cent of the voids in the sand is filled with cement paste.

$$\frac{\text{Agg. Volume Cement Paste}}{\text{Agg. Volume Voids in Sand}}$$

$$= \frac{\text{Agg. Sp. Gr. Sand}}{\text{Agg. Sp. Gr. Cement} \times \text{Weight Proportion of Sand} \times \text{Voids in Sands}}$$

$$= \frac{1.67}{1.76 \times 3 \times 0.37} = 0.85$$

Work sands having lesser voids compare favorably with standard Ottawa sand, while sands having greater voids compare unfavorably, if the comparison is made in the usual 1:3 weight proportions.

5. Tests of sands in the usual 1:3 weight proportions are not comparable, as the ratios of cement paste to voids may vary from 50 to 150 per cent.

6. Mr. M. O. Withey's tests[1] show that a volume of cement paste equal to the volume of voids in the sand gives a mortar of maximum efficiency with that sand. See Figs. 3 and 4 and Withey's Fig. 10.

7. To compare various sands, it is essential that maximum efficiency mortars be made of the various sands and the comparison reduced to cost per unit of strength. To promulgate this essential procedure in the scientific testing of mortars, it is important that the standard proportions in this specification be a maximum efficiency proportion.

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[1] "Tests of Mortars made from Wisconsin Aggregates," M. O. Withey, *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 834 (1913).

Mr. Kitts. 8. The maximum efficiency proportion for standard Ottawa sand cement mortar is approximately 1:2.6 by weight.

$$\frac{\text{Weight of Sand}}{\text{Unit Weight of Cement}} = \frac{\text{Agg. Sp. Gr. Sand}}{\text{Agg. Sp. Gr. Cement} \times \text{Voids in Sand}}$$

$$= \frac{1.67}{1.76 \times 0.37} = 2.63.$$

9. If it is desired to vary the ratio of cement paste to voids from 0.50 to 3.0, the corresponding weight proportions may be determined by inserting the desired figure in the denominator of the preceding equation.

10. Cement-sand mortars have been tested in arbitrary weight proportions for half a century more or less. No scientific law of mixtures has been developed by this procedure. It is high time that mathematical science be applied to the proportioning of mortars and concrete mixtures in testing.

Mr. Ashton. MR. ASHTON.—In order to bring the communication of Mr. Kitts before the meeting, I may say that in substance he objects to the 1 : 3 standard mortar, claiming the function of the cement should be to fill the voids entirely, and that with a 1 : 3 mixture this is not accomplished, and that theoretically the maximum efficiency proportion for standard Ottawa sand is approximately 1 : 2.6 by weight. It is very questionable in my opinion whether the actual void content has very much to do with the ultimate strength developed by the specimen. If we increase the amount of cement in the mortar, even up to a neat content, the strength seems directly in proportion to the amount of cement contained therein, irrespective of the density of the specimen.

Mr. Humphrey. MR. HUMPHREY.—I may add that this communication, as well as that of Mr. Howes, has previously been before Committee C-1 and given due consideration.

[EDITORIAL NOTE.—The discussion of the report of Committee C-1 at the annual meeting was limited, on its technical side, to the foregoing and the discussion of the "Proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar," which is given below.

An extended discussion as to whether the revised specifications shall be given the title "American Specifications and Methods of Tests for Portland Cement," as recommended by the committee, resulted in the reference of this question, by unanimous vote, to the Executive Committee. This discussion is omitted here.

For a somewhat detailed summary of the action on the report of Committee C-1, see pages 18–20.]

Mr. Chapman. Mr. Cloyd M. Chapman.—Referring to the "Proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar," which have been recommended by Committee C-1, I may call attention to the fact that another committee of the Society, namely, Committee C-9, is investigating very carefully and thoroughly the matter of size and shape of specimens and the methods of making them to secure uniform results. There is in use now a method of tests for mortar by the use of 2-in. cubes that is probably giving as much satisfaction as the methods proposed by Committee C-1 would give.

The Society is working on this subject so broadly and so thoroughly that it seems to me like taking a step before we are ready for it, to accept for publication even tentative specifications for a mortar test, on which we shall have so much more light when Committee C-9 will present its report on this subject.

Mr. Greenman. Mr. R. S. Greenman.—Speaking for the sub-committee which has been working on these compressive test specifications, I may state that we have suggested nothing definite at all, but are seeking for light, and the reason for bringing up these specifications to-day, is largely to get the sense or opinion of others upon the proposed tests. It was because of work done by Committee C-9, of which I have the pleasure of being a member, and results secured by them, which results seemed to indicate that a test piece twice the length of the diameter gave very concordant and uniform results, that this tentative test piece was suggested by Sub-committee VII of Committee C-1.

We should like to have all the suggestions and data on this subject that we can secure, but we are not going to trespass upon the work of Committee C-9 in the examination of the best size and form of test piece. Committee C-1 is only concerned to get a test piece into use that will give concordant and satisfactory values as to the cementitious quality of cement. I can

Mr. Greenman. see no harm in publishing the proposed tentative specifications in question for the purpose stated.

Mr. Chapman. MR. CHAPMAN.—I think that is a very creditable attitude to take, but we could accomplish the same purpose and yet not put out these specifications and designate them "tentative specifications," which to many would indicate that in time they may become "standard specifications," as, following precedents, they probably would. I would suggest that the committee put this matter into its report as information, to get people to think about it and to try this form of specimen, but to publish anything even remotely suggestive of a "standard" is what I object to. The probability is that the vast amount of information on this subject now being gathered will lead to the society adopting something different from this.

I would suggest, then, that the title of this matter be so altered as to indicate that this is only a method of tests which is worthy of consideration.

Mr. Greenman. MR. GREENMAN.—I should like to call attention to the first paragraph, which says "Criticisms of these tentative specifications and methods are solicited and should be directed," etc. That clearly indicates the intent of the committee. We are not trying to get anything adopted here now, but are looking for information and the more information we can get, the better it will be appreciated.

Mr. Ashton. MR. ASHTON.—As a matter of information might I ask the Secretary if it is permissible, when tentative specifications are published, to change them in absolute entirety before they are passed upon by the Society? If investigation proves that the tentative specifications were in error, is it not to be presumed that the committee appointed to carry on the investigative work will be willing to concede the point and revise the specifications, recommending them perhaps as tentative specifications for an additional year. In short, is it necessary for tentative specifications to be acted upon, and made standard specifications at the end of the first tentative period?

The Secretary. THE SECRETARY.—Under the regulations governing such matters, Committee C-1 is free to make any recommendation it may see fit concerning these tentative specifications when they are next brought up for consideration. If presented then in amended form, it would not be necessary to have them published for that reason as "tentative specifications" for another period, although if Committee C-1 should so recommend, such a recommendation would doubtless carry much weight in determining action. **The Secretary.**

MR. SANFORD E. THOMPSON.—This recommendation is a definite change from the compression specimen required by the former report, which recommends a 2-in. cube. If we change to a cylinder, and then should wish to go back to the 2-in. cube, it would be a reversal of opinion. For this reason it seems to me that while it is well to call attention to the cylindrical form, it is not advisable to put it in so definite a manner as is given in the report, and that we should change the wording so as to make its tentative nature still more apparent. **Mr. Thompson.**

MR. P. H. WILSON.—As I understand it, Committee C-1 has the power to withdraw these tentative specifications at the end of the year; to amend them; or to recommend their adoption. **Mr. Wilson.**

THE SECRETARY.—That is correct. **The Secretary.**

MR. P. H. BATES.—As a member of the sub-committee which recommended this cylinder, I should like to inquire of the chairman of Committee C-9 where the 2-in. cube has been specified as a compression test? **Mr. Bates.**

MR. THOMPSON.—The 2-in. cube is recommended in the 1912 Report of the Special Committee of the American Society of Civil Engineers on Uniform Tests of Cement. **Mr. Thompson.**

MR. W. M. KINNEY.—I think that undue importance is being given to the 2-in. cube. It is merely mentioned in the A. S. C. E. methods for testing cement. I do not believe that there are a dozen laboratories in the country that ever bought the molds for it. It is true that more investigative work ought to be done on the 2-in. cube, but it has been pretty well established that the restraint of the heads of the testing machine is so great on a specimen of that size that it unduly influences the test. A 2 by 4-in. cylinder has been determined to be a very satisfactory test piece, and I cannot understand why there should be any objection to it. **Mr. Kinney.**

[A motion by Mr. Richard L. Humphrey that the Tentative Specifications and Tests for the Compressive Strength of Portland Cement Mortar be accepted for publication, was carried.]

Mr. Enright. MR. BERNARD ENRIGHT (*by letter*).—I desire to discuss certain features of the Methods of Tests for Portland Cement submitted by Committee C-1.

In connection with the determination of "Sulfuric Anhydride," a point of prime importance in the determination by the method suggested is to have conditions such as to assure no separation of the silica, subsequent to the initial filtration, to contaminate the barium-sulfate precipitate and thus yield high results. The addition of 5 cc. of concentrated hydrochloric acid diluted with 5 cc. of water, to 1 g. of cement, as recommended in the method, will frequently result in the caking of the cement, making solution difficult, and also making for conditions which might permit subsequent separation of silica with the barium sulfate.

In order to obtain accurate results, extreme care is necessary in this preliminary solution, a point which I think it might be well to emphasize. In my own practice, I first get the 1 g. of cement thoroughly in suspension by adding, in a stream from a wash bottle, directed to obtain this result, about 30 cc. of water. Continuing the violent agitation, 20 cc. of hydrochloric acid of a mixture of 1 part acid to 2 parts water are then introduced, solution resulting practically immediately, with no caking or separation of gelatinous silica, either in this solution or subsequent to filtration.

No details are given regarding the washing of the barium-sulfate precipitate. If this is done with water alone, it is occasionally found impossible to free the paper entirely from traces of ferric chloride, this iron then contaminating the barium-sulfate precipitate, and also tending towards a high result. Such contamination, if present to an appreciable extent, reveals itself in a discoloration of the ignited, normally pure white, barium sulfate.

Two washings with dilute hydrochloric acid, with one intervening washing with water, on transferring the precipitate from the beaker to the filter paper, will entirely prevent any trace of iron contamination. Lengthy experiments which I conducted at the Bethlehem Steel Co. in 1894 proved that barium sulfate is slightly soluble in dilute hydrochloric acid, for which I substituted, as a wash, a mixture of 3 parts water

Mr. Enright. and 2 parts hydrochloric acid containing 1 per cent of barium chloride, in which wash solution barium sulfate is absolutely insoluble. While this refinement is necessary in aiming for accuracy within a couple of thousandths of one per cent, as in iron analysis, it is probably unnecessary in cement analysis, where much larger proportions are dealt with, where the effect on quality of variation in percentage of ingredient is not nearly so pronounced, and where there is a permissible variation of 0.10 from the specified value of 2.00 per cent.

In reference to the determination of "Loss on Ignition," it is recommended to blast for 15 minutes. Carbon dioxide and combined water, both of cement and of gypsum, are readily driven off at a red heat, such as is easily obtained by an ordinary Bunsen burner with gas. The blast-lamp equipment of some laboratories is designed to give a much higher temperature, and blasting under these conditions might result not only in expulsion of carbon dioxide and combined water, but in actual decomposition, to a greater or less extent, of the sulfate of lime of the gypsum, the ignition loss obtained being unduly higher to the extent of the amount of expulsion of this decomposition product.

It might be well to substitute the words "heated" and "heating" for "blasted" and "blasting" in method (*a*).

Under "Determination of Fineness," in referring to the 200-mesh sieve, the following statement appears: "No opening between adjacent parallel wires shall be more than 0.0050 in. in width."

With equally spaced wires 0.0021 in. in diameter, the width of the openings would be 0.0029 in. each. If the wires were 0.0023 in. diameter, the opening widths would be 0.0027 in. If then, a standard 200-mesh sieve was made up of 0.0023 in. wire, with each alternate wire absolutely accurately spaced, all the other wires, representing half the total number of wires contained in the sieve, instead of being placed midway between the first wires referred to, would actually have to be placed practically directly alongside of, almost in actual contact with, the first lot of wires in order to violate this requirement. If instead of being placed in actual contact, they were placed only 0.0004 in. away, the requirement that no opening should

Mr. Enright. be more than 0.0050 in. in width would be complied with. In this case the openings on one side of the misplaced wires, or half the total openings, would be 0.0004 in. in width, and those on the other side, the other half of the total openings, would be 0.0050 in. in width.

It is recognized, of course, that the other requirements are designed to safeguard the question of sieve accuracy, but it would appear, nevertheless, that the clause quoted tends to add weakness, rather than strength, to the specification.

In Fig. 4, two pats with shrinkage cracks are among the six cuts shown. Shrinkage cracks are by no means any evidence of unsoundness—in fact there is no connection whatever between shrinkage and unsoundness. While these pats are marked "shrinkage," the fact that they appear over the general title, "Typical Failures in Soundness Test," is liable to prove confusing and misleading.

As is well known, an enormous amount of work, extending over several years, has been done in arriving at this revision, and it would seem highly desirable to put these revised specifications into effect at as early a date as possible, certainly, at least, by January 1, 1917.

Referring to the proposed Tentative Specifications and Methods of Tests for Compressive Strength of Portland Cement Mortar, our laboratories have been equipped, for the past four years, with the complete standard German compression testing apparatus, and I have been making, during this period, compression tests with this apparatus and according to the German Standard Specifications. A number of points have been developed during this work, which may prove of interest.

In Germany compressive strength tests and requirements have entirely superseded tensile strength requirements in their standard specifications. As a rule, the published results of compression tests made in Germany on German cement far exceed in strength the published results of compression tests made in this country, on American cements, by the various and widely different methods in vogue here. This would seem to indicate superiority on the part of German cement. Such a conclusion I have found, however, to be entirely unwarranted.

In making the small test pieces required for determining tensile strength, an experienced operator, placing the mortar

Mr. Enright. in the briquette mold by thumb pressure alone, as provided by specifications, will obtain almost as dense a mixture and nearly as high results on breaking, as he would by hammering the mortar in. No such close results can be obtained, however, by the different methods indicated on the much larger test pieces required for the determination of compressive strength.

The German compressive strength on 1:3 cement-sand mortars, as officially reported by them, generally shows about 3000 to 3500 lb. per sq. in. at the end of 7 days (1 day in moist air and 6 days in water), and about 4500 to 5000 lb. per sq. in. at the end of 28 days (1 day in moist air and 27 days in water). Such results, as stated, are much higher than published American results on American cements.

In my tests with the German apparatus and according to German standard methods of testing, I have occasion to examine various American brands—in fact, make tests almost daily on one brand in particular. I find under these conditions that the compressive strength results obtained not only equal, but in fact, decidedly exceed the German results. On 1:3 mortars, a compressive strength of about 4500 to 5000 lb. per sq. in. is obtained in 7 days, and of about 6000 to 7500 lb. per sq. in. at the end of 28 days (1 day in moist air and 27 days in water).

In view of the above facts, and particularly in view of the possibility of development of a substantial export trade, I do not think it would be wise to adopt standard compressive strength requirements materially lower, if at all lower, than those of the German standard specifications; nor would it seem advisable to adopt any method of making the tests which would, on the same cement, give materially lower results than would the German standard methods. These German methods of testing have been in vogue, and the compressive strength results published, over a period of a great many years, and in foreign countries, or possibly even in this country, are probably looked upon as a standard to which other brands should measure up.

In the 28-day tests, higher results are obtained on test specimens immersed, after 24 hours in moist air, for a period of 6 days in water, and then removed and allowed to remain for 21 days in air, than can be obtained on the same test specimens immersed, after 24 hours in moist air, for the full remaining 27 days in water.

Mr. Enright. This point might bear consideration. That it is recognized in Germany is shown by the fact that one of their specifications cover such a test. The German standard compressive strength requirements are, on 1:3 cement-sand mortars, a strength of at least 120 kg. per sq. cm. (equivalent to 1707 lb. per sq. in.) at the end of 7 days (1 day in moist air and 6 days in water), and of at least 200 kg. per sq. cm. (equivalent to 2845 lb. per sq. in.) at the end of 28 days (1 day in moist air and 27 days in water). On the 28 days tests involving 24 hours in moist air, 6 days in water, and 21 days in air of a temperature of 15 to 20° C., the compressive strength required on 1:3 mortars is 250 kg. per sq. cm. (equivalent to 3556 lb. per sq. in.). This latter test is their decisive test in passing upon quality.

These requirements are far higher than those of the proposed tentative specifications—1200 lb. per sq. in. at 7 days and 2000 lb. per sq. in. at 28 days.

Committee C-1. OFFICIAL CLOSURE BY LETTER ON THE PART OF COMMITTEE C-1.—Mr. Enright's discussion is of particular value, in that it calls attention to the fact that certain precautions are necessary in the determination of sulfuric anhydride in order to obtain accurate results. However, if the method, as outlined by the committee and contained in the specifications, is followed, it is felt that the errors suggested by Mr. Enright will not occur. If, however, the conditions are not rigidly followed, all the difficulties mentioned may result. If the solution is allowed to become too concentrated, it invariably happens that the barium-sulfate precipitate is contaminated with iron. Also if the barium-chloride solution is added too rapidly, or to a too cold solution, a more gelatinous precipitate is obtained which occludes some of the iron and is washed free from it with great difficulty. But on the other hand, the slow addition of the barium chloride to the boiling solution and continuing the boiling until the precipitate is well formed and settles rapidly, results in the formation of a crystallin barium sulfate which can be easily washed free of the iron salts with water alone.

The paragraph on ignition loss specifically states that the blasting should be at a dull red heat. If a blasting is made at a color approaching a white heat, then undoubtedly some of the gypsum will be decomposed with the loss of sulfuric anhydride. **Committee C-1.** The committee, however, is well aware of the fact that while many blast lamps would, if used to their highest efficiency, give too high a temperature, many Bunsen burners used at their best efficiency will give too low a temperature. It therefore specified the use of a blast lamp, but also defined in a sufficiently definite manner the approximate temperature at which it should be used.

Apparently the calculation in regard to the spacing of the wire in the 200-mesh sieve is correct, but it was for this reason that the committee adopted the specifications of the Bureau of Standards for the 200-mesh sieve. In these specifications the final criterion of the value of the sieve is the variation which is shown in the standardized cement. No sieve with the spacing suggested in the latter part of Mr. Enright's discussion, would pass the specification:

> "The value of the sieve, as determined by the sieving tests, made in conformity with the standard specifications for these tests on a standardized cement which gives a residue of 25 to 20 per cent on the No. 200 sieve, or other similarly graded material, shall not show a variation of more than 1½ per cent above or below the standards maintained at the Bureau of Standards."

It might have been well for the two shrinkage pats, shown in Fig. 4, to have been made a separate figure. On the other hand, there is a footnote on the previous page which calls particular attention to the fact that shrinkage cracks are not indications of unsoundness, and refers directly to the illustrations in Fig. 4.

The committee appreciates very much Mr. Enright's discussion of the compression tests. It especially invites, furthermore, discussions from all who have been making tests of the compressive strength of American Portland cement mortars. In this connection, however, it would be well to receive with the discussion the full data upon which the discussion is based, and furthermore the methods which have been followed in obtaining these data.

REPORT OF COMMITTEE C-4

ON

CLAY AND CEMENT SEWER PIPE.

In its report[1] to the Society in 1911, the committee presented a "Schedule of Analytical Data for Sewer Pipe" in interrogatory form, as an aid to the committee in its consideration of two important features of its work, namely, (1) the demands made upon sewer pipes with reference to the conditions affecting their strength, durability and serviceability, and (2) practical examinations and tests to secure materials and manufacture of pipe answering the foregoing demands. This work has progressed very favorably, and the committee presents as an Appendix to this report, under the title "Analytical Data for Sewer Pipe" all the data obtained up to this time bearing upon the above questions. These data have been carefully digested by the committee, and are presented as nearly as possible in the manner outlined by the interrogatory schedule published in 1911. Certain subjects, including that of conditions affecting durability, are still in the hands of various sub-committees, and have been so indicated.

It is recommended that the "Analytical Data for Sewer Pipe" be published for one year for discussion and criticism.

The third class of work referred to in the 1911 report, namely, the methods of laying pipes under the usual conditions occurring in practice, reached a more advanced stage in the presentation by the committee[2] in 1914 of "Memoranda of Recommendations for the Laying of Sewer Pipe," which, upon the recommendation of the committee[3] in 1915, was published among the tentative standards in the 1915 Year-Book[4] under the title "Recommended Practice for the Laying of Sewer

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XI, p. 153 (1911).

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 195 (1914).

[3] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 163 (1915).

[4] P. 553.

Pipe." As stated in its report last year, final consideration of this question must await the full presentation of data with respect to demands upon sewer pipes and to practical examinations and tests.

The committee recommends this Recommended Practice be again reprinted among the Tentative Standards, with the following minor changes, the page numbers referring to the 1915 Year-Book.

1. Page 553, line 17 from bottom: For the words "a rupture" substitute "possibly an excessive pressure and consequent rupture."

2. Page 554, line 2: For the word "required" substitute "advisable."

3. Page 554, line 22: For the word "undue" substitute "excessive."

4. Page 554, line 25: After the words "springing line" add "to maintain firm joints."

5. Page 555, line 5: After the word "bed" add "and broken."

6. Page 555, line 6: For the words "of suitable material" substitute "with suitable material."

7. Page 555, line 17: After the words "special precautions are necessary" add "to prevent undue pressure upon the pipes."

8. Page 555, line 39: After the word "indicate" add "to be necessary for the stability of the pipes."

9. Page 556, line 15: Strike out the sentence: "Unless otherwise permitted or directed, not less than 20 ft. of pipe sewer should be laid in one operation."

10. Page 556, line 18: For the words "so that the mortar will not be shoved into the hub or the joint be unnecessarily large" substitute "so that the joint will not be unnecessarily large."

11. Page 557, line 19: Strike out the words "especially strong pipes or."

12. Page 557, line 28: For the words "heated to a suitable temperature, or, if directed" substitute "heated to a temperature determined by the engineer, or he may advise that."

13. Page 557, line 32: For the words "be heated" substitute "be similarly heated."

14. Page 557, line 35: For the words "unless otherwise directed" substitute "unless other protection of the pipe is directed."

This report, with the Appendix, has been submitted to letter ballot of the committee, which consists of 19 members, of whom 10 have voted affirmatively, 5 negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

RUDOLPH HERING,
Chairman.

E. J. FORT,
Secretary.

A. J. PROVOST, JR.,
Vice-Chairman.

EDITORIAL NOTE.

The proposed Tentative Recommended Practice referred to in this report was accepted for publication in its amended form, and appears on pages 472–478.

APPENDIX.

ANALYTICAL DATA FOR SEWER PIPE.

FIRST CLASS OF DATA: THE DEMANDS MADE UPON SEWER PIPES.

The committee is of the opinion that before final conclusions may be reached regarding the specifications and tests for clay and cement sewer pipes, there must be substantial agreement as to the demands made upon them under conditions as they ordinarily arise in practice.

With these demands established, it will then be possible to consider the necessary properties of the several materials, and to recommend the practical tests which should be applied thereto in order to determine the compliance with the demands.

In order to state the general demands upon sewer pipes we shall consider separately those which relate to strength, durability and serviceability.

I. CONDITIONS AFFECTING STRENGTH.

The pipes must have sufficient strength to resist the forces that are applied both externally and internally, and these forces may be considered separately.

External Forces.

1. Forces acting upon the outside of the pipe may be either static or dynamic.

(*a*) *Static Forces.*—The static forces applied to the outside of a pipe are those resulting from the loads or quiescent pressures acting upon it. These loads or pressures are made up of the weight of the body of material resting vertically over the pipe, either with its weight in entirety or reduced by the cohesion with the adjoining material, and transmitted as components of forces deviating from the vertical, and acting outside of the body resting vertically over the pipe.

The trench filling is usually kept free from large stones and consists of clay, loam, gravel, sand or of their mixture. A compacting of this material is produced by ramming or watering of the trenches, which increases the weight per cubic foot and thereby the pressure upon the pipes. The maximum weights which cause vertical pressure upon the pipes, and which must be sustained by them, are therefore determined by knowing the weight per cubic foot of the compacted superincumbent material, its depth in feet and the weight of any possible load that may rest on the surface above the trench.

If the material above the pipe were a liquid without cohesion we could obtain the exact pressure upon the pipe in the manner above indicated. Where the cohesion of the material is great, as in rock,—in other words, if the pipe is laid beneath a roof of rock,—there would be no pressure at all upon the pipe.

In the usual trench filling, we therefore have all possible degrees of cohesion varying from a puddled filling which may act as a liquid, and transmit the full weight of the material upon the pipe, to a material such as hard-pan or rock which sustains itself and transmits no weight to the pipe.

In practice, therefore, we can expect great differences in the pressures of the materials over pipes, which fact explains the differences of opinion prevailing as to the proper weight allowance upon pipes and of the formulas suggested[1] therefor to determine such pressures. Table I gives the weights of various trench-filling materials for different heights of fill.

The material on both sides of the mass resting vertically over the pipe,—unless it is hard-pan or rock,—may by sliding press upon the pipe in directions other than vertical. In other words, the pressure will act by its components. One set of these components will always be horizontal and if the pressure is alike on both sides of the trench, the two opposing components will completely balance each other. The other set of components will be vertical and their action is resisted by the friction against the original trench wall on each side of the pipe. Where the original components act upon the pipe itself they will again be divided into components; one set will act at right angles to the exterior surface thereof,—

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[1] Frühling, Barbour, Marston and others.

in other words, press towards the center of the pipe. They will, therefore, press horizontally at the horizontal diameter of a circular pipe; they will press downwards above it and upwards below it. The other set will act within the shell of the pipe and parallel to the surface.

(*b*) *Dynamic Forces.*—The dynamic forces are those which may result from bodies moving either quietly or suddenly, and in such manner that the resultant force, or its components, can act directly upon the body of the pipe. Such dynamic forces are caused by a heavy moving load passing over the trench in which a pipe is laid. They may be the effect of a body of earth sliding or settling in or near the trench; or they may be the impact of a body upon the pipe, as that of a falling stone or of the pipe itself falling upon the ground.

TABLE I.—WEIGHT IN POUNDS OF TRENCH-FILLING MATERIALS.

Height of Fill, ft.	Loose Top Soil.	Top Soil Clay.	Dry Sand.	Damp Sand.	Top Soil, Tamped.	Clay and Sand, Tamped.	Sand, Tamped.	Sandy Loam, Tamped.
2........	140	160	194	182	226	218	230	192
4........	280	320	388	364	452	436	460	384
6........	420	480	582	546	678	654	690	576
8........	560	640	776	728	904	872	920	768
10........	700	800	970	910	1130	1090	1150	960
12........	840	960	1164	1092	1356	1308	1380	1152
14........	980	1120	1358	1274	1582	1526	1610	1344
16........	1120	1280	1552	1456	1808	1744	1840	1536
18........	1260	1440	1746	1638	2034	1962	2070	1728
20........	1400	1600	1940	1820	2260	2180	2300	1920

The maximum static equivalent of live loads which may pass over a sewer trench should be 300 lb. per sq. ft. of surface. This load may be increased by 87 per cent for impact. Bodies falling upon the pipe which cause greater stress than those produced by the drop-weight test need not be considered as a condition to be guarded against by greater strength of pipe.

Internal Forces. 2. Internal forces which are imposed upon sewer pipes under conditions of use are hydrostatic pressure and water hammer.

(*a*) *Hydrostatic Pressure.*—Hydrostatic pressure, as usually expressed, is the weight in pounds of a column of water of 1 sq. in. section, having a height which extends from the point where the pressure is to be measured, up to the highest elevation of any connecting water standing outside of the pipe. Table II gives the hydrostatic interior pressures per square inch at various depths to which sewer pipes may be exposed in practice.

TABLE II.—HYDROSTATIC INTERIOR PRESSURES.

Depth, ft.	Pressure, lb. per sq. in.
2	0.868
4	1.73
6	2.50
8	3.47
10	4.34
12	5.20
14	6.07
16	6.94
18	7.81
20	8.68
22	9.54
24	10.41
26	11.06

Tests made of the resistance to bursting pressure of well-made pipe show it to be so much greater than the sewer pipe is subjected to, that the demands for this purpose may be neglected. This is the more true, since the hydrostatic pressure will usually receive less resistance in the joints than in the pipes themselves.

(*b*) *Water Hammer.*—A water hammer in a pipe is caused by the shock against the barrel of a pipe of a sudden stoppage of the flow of water within it. This stoppage may result from a sudden closing of a valve or a sudden clogging by floating or suspended material, or by a break of the pipe and caving in of the trench.

The maximum force of a water hammer tending to break the pipe depends on the mass of water in motion and its velocity.

(*A*) PROPERTIES OF RAW MATERIALS.

Clay Pipe.

3. The clays or shales used for the manufacture of sewer pipes should possess those physical and chemical properties which will secure strong, tough vitrification at moderate heat, and absence of excessive warping, shrinking, fire cracks and other objectionable defects in the finished product.

The committee will present more complete and detailed statements with respect to these required physical and chemical properties when the necessary data is supplied by those most familiar with these properties.

Adulterants, such as fine grindings from well-burned clay, may be used to reduce shrinkage, etc., provided the strength or durability of the finished pipe is not thereby diminished.

The water used in tempering the clays or shales should be free from salts, alkali, acid, mineral and gaseous impurities in quantities such as have been found in practice to render the water unsuitable for this special purpose.

Cement-Concrete Pipe.

4. (*a*) *Cement.*—The cement used should be Portland cement, whose physical and chemical properties comply with the Standard Specifications and Tests for Portland Cement (Serial Designation: C-9) of the American Society for Testing Materials.

(*b*) *Sand.*—The sand used should consist of grains from hard, tough, durable rock, and be free from soft, decayed and friable material. It should be free from lumps of clay, loam or other foreign material. It should not contain more than 2.5 per cent by weight of finely divided clay, loam or other suspended matter. The grains should have rough, unpolished surfaces, and be well graded in size from the finest to the coarsest. Not more than 8 per cent by weight, including suspended matter, should pass the No. 100 sieve, and not more than 60 per cent should pass the No. 16 sieve. None of the grains should be retained on the No. 4 sieve.

Mortar in the proportions of 1:3 by weight when tested at the age of 28 days, should develop a tensile strength at least equal to the strength of a similar mortar made of the same cement and standard Ottawa sand tested at the same age.

(*c*) *Stone and Gravel.*—The broken stone used should be irregular pieces of crushed trap or other hard, tough, durable rock in graded sizes. None of the pieces should be less than $\frac{1}{4}$ in. in minimum diameter, and none larger in maximum diameter than three-tenths of the thickness of the sewer pipe in which it is to be used. The stone should be washed if necessary to remove dust, dirt or other foreign substances.

Gravel of the same degree of hardness, toughness and durability, and of the sizes specified for stone, may be used in place thereof if free from dust, dirt and other foreign substances.

The stone and sand, or the gravel and sand, should each be of such graded sizes that, when mixed with cement in definite proportions, and with the required amount of water, they will produce a mass of maximum weight and density.

(*d*) *Water.*—The water used for the concrete should be fresh (not salt) water, free from excessive turbidity, sulfur, carbonic acid and other mineral or organic substances detrimental to its use for this special purpose.

(*e*) *Waterproofing Compounds.*—Waterproofing compounds, if used, should possess such physical and chemical properties as are necessary to render the concrete impervious to water without adversely affecting its strength or durability.

(*B*) MANUFACTURED PIPE.

Proportions of Ingredients of Cement-Concrete Pipe.

5. The proportions of ingredients of cement-concrete pipe shall be at least equal to that of first-class gravel concrete of proportions, 1 part of first-class Portland cement, to 1 part of clean, coarse graded sand, to 1 or 2 parts pebbles.

Porosity or Compactness.

6. A pipe which is very porous will allow passage in and out of water or sewage through its shell. This passage or slow percolation of water is, from a sanitary point of view, of little moment in all but rare cases and then it requires special consideration. The porosity of the shell is, however, of importance with reference to its bearing upon the strength of the pipe, when this is subject to either external or internal forces. As affecting the strength of a pipe the degree of its allowable

porosity will depend upon the character of the material and the process of manufacture of the pipe. The stronger the final product, the less objectionable will be a greater degree of porosity. In the case of cement-concrete pipe we must, however, consider the effect of percolation of acid or alkali water which tends to disintegrate the hard carbonate of lime. Experience has shown that the greater the porosity the quicker is the disintegration. It has also shown that for normal sewage the effect is negligible if the material is uniformly compact and the percolation extremely slight.

It is, therefore, the opinion of the committee that the actual effect of porosity upon the strength of a pipe should be determined by more experiment and that, therefore, tests should be made so as to indicate the most economical relations between strength and porosity for the principal classes of material and manufacture now in the market. The results of such tests should be published for each make, indicating the actual porosity for tested strengths of pipe. When subjected to an internal pressure of 10 lb. per sq. in., sewer pipe shall show no percolation.

Toughness.

7. The quality of toughness in the material of sewer pipes, which is the opposite of brittleness, is important, as it affects their being readily broken by handling before they are laid, or broken by internal forces, such as water hammer, after they are laid.

The toughness of pipe is best ascertained and measured by the impact of a body having a fixed weight and drop distance, when striking the center of a pipe fixed in a horizontal position. The degree of toughness as thus measured should be sufficient to prevent rupture under the above-stated ordinary conditions, which demands a somewhat arbitrary standard depending more or less on local practice. The committee recommends a drop test as follows:

When supported on a dry sand bed 2 in. deep, all pipe shall withstand, without cracking, the impact from two blows of a cast-iron ball weighing 8 lb. falling 18 in. Spurs shall resist, without fracture, the impact from two blows of such a ball falling 6 in. and striking on the extreme end of the hub of the spur.

Vitrification of Clay Pipe.

8. The vitrification of clay pipe should be carried as far beyond its first indication as practicable, because it increases the strength of the pipe. But it should not be carried to a degree that would lower the desired degree of toughness.

The standard for vitrification must, therefore, also be arbitrary, and it depends not only upon the degree of desirable toughness, but also upon the properties of the raw materials used.

Further discussion of this subject must await the receipt of report from the sub-committee to which it has been referred.

Defects in Clay Pipe.

9. Defects in clay pipe are fire cracks, blisters and laminations. These imperfections should be avoided so far as practicable, because to some extent they reduce the strength of the pipe. The reduction is found particularly when the fire cracks in a pipe are abundant and extend far into the shell. It is also found when the material is laminated, and particularly when the breaking shows splitting between layers of material. Blisters, unless very deep, do not affect the strength, but rather the serviceability, of a pipe.

The permissible limits of these defects should, therefore, also be arbitrary standards, depending upon the purposes for which the pipes are to be used.

Where high strength is required, fire cracks should be rare. Where they occur they should never extend into the shell more then $\frac{1}{8}$ in., irrespective of the test for strength. Where laminations occur in pipes such should cause rejection, unless the tests for strength are quite satisfactory for the proposed use of the pipes.

Hair Cracks in Cement-Concrete Pipe.

10. Hair cracks are caused by shrinkage of the cement during the process of drying and setting, and when exposed to a material drop in temperature soon after setting.

The permissible limits must be arbitrary and should depend upon the purposes for which the pipes are to be used. Such cracks unquestionably lower the strength of the pipe. They should therefore be rare, and never destroy the continuity of the material of a section of the shell more than 1 sq. in., and such depreciated cross-sections should not be less than 6 in. apart. Such individual hair cracks should not exceed 0.1 mm.

in width, and should not be more than 2 in. long, and not penetrate the shell more than $\frac{1}{8}$ in.

Thickness of Shell.

11. The thickness of the shell of a pipe, to resist external and internal forces, strictly speaking, should vary with the qualities of the original material from which the pipe is made and with the treatment during its manufacture. A thinner shell of tougher and denser material may resist greater pressure than a thicker pipe which is less tough and compact.

The committee therefore believes it would be unsafe to specify a definite relation between diameter of pipe and the thickness of shell, and that it must be left to the guarantee of the manufacturer that the pipe which he offers for sale shall be, in all cases, of sufficient thickness to withstand the standard crushing loads specified.

The committee favors the establishment of a minimum thickness for each size of sewer pipe and submits, as a result of all the available information, Table III for consideration.

The committee is of the opinion that there may be a demand at times, for cheaper pipes with thinner shells than those above specified, but it believes that in such cases the understanding should be clear that such pipe is not classified as standard pipe.

There may also be a demand at times, for pipe which must safely sustain a greater weight than the above standard. In such exceptional cases, means should be provided for securing the necessary increase of strength, either by embedding standard pipes in concrete or by surrounding them with concrete of sufficient thickness to resist the greater weight.

Ends of Pipe.

12. The ends of pipe should be so shaped as to permit the making of a joint which, in strength, approaches the strength of the pipes in resistance to shear, bending moment and crushing stresses, and which is also sufficiently impervious to the passage of water. In vitreous materials it is impracticable to obtain that accuracy of dimensions which will permit close contact at all points of the pipe ends, and for this reason the strength of jointed pipes in these materials is to be secured by means of the jointing material. For this purpose it is best to have space for ample jointing material such as is furnished by extra wide and deep sockets. The outside surface of the spigot end and the inside surface of the hub or socket end

should be unglazed, or else these surfaces should be scored with V-shaped depressions to provide for a bond with the jointing material.

Where the ends of pipes can be finished to true surfaces, as with cement-concrete pipes, it is practicable to shape these ends as male and female bevels which can be brought into close contact throughout. Such a joint, when covered with a suitable layer of cement mortar to increase the rigidity and to prevent the passage of water, is quite as satisfactory as the hub-and-spigot type with extra wide and deep sockets, although it does not appear to have any particular advantage over the latter except possibly some economy in handling and laying. The ends of cement-concrete pipe furnish good bonding surfaces for the jointing materials and, therefore, do not require to be scored. Table IV gives minimum values for depth of socket and annular space for various diameters of pipe.

TABLE III.—MINIMUM THICKNESS OF SHELL.

Diameter of Pipe, in.	Minimum Thickness of Shell, in.	
	Vitrified Clay Pipe.	Cement-Concrete Pipe.
6	$\frac{5}{8}$	$\frac{3}{4}$
8	$\frac{3}{4}$	$\frac{7}{8}$
10	$\frac{7}{8}$	1
12	1	$1\frac{1}{4}$
15	$1\frac{1}{4}$	$1\frac{1}{2}$
18	$1\frac{1}{2}$	$1\frac{3}{4}$
20	$1\frac{2}{3}$	2
22	$1\frac{5}{6}$	$2\frac{1}{4}$
24	2	$2\frac{1}{2}$
27	$2\frac{1}{4}$	...
30	$2\frac{1}{2}$	...
33	$2\frac{5}{8}$	...
36	$2\frac{3}{4}$	...
42	$3\frac{1}{2}$	...

Age of Cemen Concrete Pipe before Use.

13. No pipe should be used until pipes cast in the same factory of equal age are strong enough to meet the specified crushing test.

Making of Joints.

14. Recommendations with respect to the making of joints have been furnished in the proposed Tentative Recommended Practice for the Laying of Sewer Pipe, as heretofore reported by the committee and published in the 1915 Year-Book.[1]

Gasket and mortar joints, in vitrified pipe sewers, shall be made in the following manner:

A closely twisted hemp or oakum gasket of suitable diameter, in no case less than $\frac{3}{4}$ in., and in one piece of sufficient length to pass around the pipe and lap at the top, shall be solidly rammed into the annular space between the pipes with a suitable calking tool. Before being placed, the gasket shall be saturated with neat cement grout. The remainder of the space shall then be completely filled with plastic mortar mixed 1:1 and the joint wiped inside and finished to a smooth bevel outside.

TABLE IV.—MINIMUM DEPTHS OF SOCKET AND ANNULAR SPACES.

Diameter of Pipe, in.	Depth of Socket, in.	Annular Space, in.	Diameter of Pipe, in.	Depth of Socket, in.	Annular Space, in.
6............	$2\frac{1}{2}$	$\frac{5}{8}$	22............	$3\frac{3}{4}$	$\frac{5}{8}$
8............	$2\frac{3}{4}$	$\frac{5}{8}$	24............	4	$\frac{5}{8}$
10............	$2\frac{3}{4}$	$\frac{5}{8}$	27............	4	$\frac{3}{4}$
12............	3	$\frac{5}{8}$	30............	4	$\frac{3}{4}$
15............	3	$\frac{5}{8}$	33............	5	$1\frac{1}{4}$
18............	$3\frac{1}{4}$	$\frac{5}{8}$	36............	5	$1\frac{1}{4}$
20............	$3\frac{1}{2}$	$\frac{5}{8}$	42............	5	$1\frac{1}{4}$

Joints of sanitary pipe sewers below the normal water table shall be made with a compound approved by the chief engineer. The compound shall preferably have a bituminous base, shall adhere firmly to the glazed surfaces of the pipes, shall melt and run freely at a temperature as low as 250° F. and when set shall be sufficiently elastic to permit of a slight movement of the pipes without injury to the joints or breaking the adhesion of the compound to the pipes. The compound shall not deteriorate when submerged in fresh or salt water or normal domestic sewage; it shall show no deterioration of any kind when immersed for a period of five days in a 1-per-cent solution of hydrochloric acid or a 5-per-cent solution of caustic potash.

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[1] Pp. 553–558. This Recommended Practice in slightly revised form will be found appended to this report.—ED.

After a joint is properly calked, a suitable runner shall be placed and the compound, heated to a temperature of approximately 400° F., shall be poured into it in such a manner that the annular space shall be completely filled to within ½ in. of the outer rim of the bell of the pipe.

Unless otherwise permitted, at least four finished joints shall be left exposed for inspection throughout the working day, and the necessary staging for the protection of the exposed sewers and for the handling of excavated material shall be provided. The joints on the inside of all pipe sewers larger than 15 in. in diameter, shall be carefully filled with mortar and wiped smooth and flush with the surface of the pipe.

Branches, Spurs, etc.

15. (*a*) *Method of Attachment to Pipe.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

(*b*) *Angle of Junction with Pipe.*—The angle should be 45 deg., with a deviation of not more than 5 deg.

(*c*) *Dimensions.*—Branches, spurs, etc., shall be of the same dimensions as specified for pipe sewers of similar size.

II. CONDITIONS AFFECTING DURABILITY.

Discussion of this subject must await the report of the sub-committee to which it was referred.

III. CONDITIONS AFFECTING SERVICEABILITY.

Sewer pipes should be manufactured in a manner so that they will be as serviceable as practicable. This result can be had by obtaining conditions in the pipe which will secure a complete and rapid delivery of the sewage, and a sufficient degree of ease and economy in handling and laying the pipes.

The discharge of sewage through a pipe line or sewer made up of units which are separately made and laid upon a specially prepared foundation, and which are solidly joined with a binding material, is facilitated by giving the interior of the pipe a regular and smooth surface, by limiting the deviations which may be allowed from the true sectional form, and by minimizing the number of joints and the defects which may cause excessive percolation or leakage, or render troublesome the securing of tight joints.

(*A*) COMPLETE AND RAPID DISCHARGE OF SEWAGE.

Smoothness of Interior Surface.

16. Sewage carries in suspension floating, light and fibrous matter; and while it flows, drags along the bottom of the pipe heavy matter, which matter may be held back by projections and irregularities and even by the roughness of the surface of the pipe. The glutinous and sticky condition of many sewage particles, and their putrefaction when held back on the sides or bottom of the pipe, are the chief reasons for requiring, as essential for sewer work, a regular and smooth condition of the interior surface of the pipes and their joints.

(*a*) *Glazing of Clay Pipe.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

(*b*) *Fire Cracks and Blisters in Clay Pipe.*—The smoothness of the interior surface of the pipe is affected very slightly by fire cracks, but sometimes quite perceptibly by projecting blisters and teats which are apt to hold back putrescible matter, and cause it to become foul before it is discharged; also to retard the velocity of flow to some extent by an increase of friction. A substantial absence of such projections is therefore desirable.

(*c*) *Projecting Joints in Clay Pipe.*—The tendency of hard-burned clay pipe to warp in the process of manufacture makes it difficult to form a perfect joint between pipes without some projection. There is practically no warping in cement-concrete pipe.

In order to offer the least projection to the flowing sewage, it is customary to lay the pipes so that the inside bottom at the joints is flush, and that the greatest projection will be at the inside top. In Table V the committee gives what it considers to be the maximum permissible variation from the true sectional form of sewer pipe.

(*d*) *Natural Surface of Cement-Concrete Pipe.*—To obtain the desired smoothness of the interior surface of cement-concrete pipe, it is desirable to use a hard, smooth-surface material, such as steel, for a mold forming the core for the pipe. A uniformly mixed material of sufficient richness will produce a surface not only of any desired degree of smoothness but also of imperviousness at the surface. The absence of warping will allow the pipes to be joined without projections to retard the flow of sewage.

(*e*) *Coatings of Cement-Concrete Pipe.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

Table V.—Permissible Variation from True Sectional Form of Clay Pipe.

Standard Internal Diameter of Pipe, in.	Permissible Deviation from Standard, in.
To 6, incl	$\frac{3}{16}$
7 to 10, incl	$\frac{1}{4}$
11 to 15, incl	$\frac{5}{16}$
16 to 20, incl	$\frac{3}{8}$
21 to 24, incl	$\frac{1}{2}$
25 to 30, incl	$\frac{5}{8}$
31 to 42, incl	$\frac{3}{4}$

(*f*) *Linings of Cement-Concrete Pipe.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

(*g*) *Branches and Spurs.*—The special pipes which have branches and spurs attached must have these attachments joined with great care so that the resistance to the flow of sewage is not unduly increased. If the branch is at either side of the pipe, the angle of the connection should not be greater than 45 deg. If it is at the top of the pipe, the branch may be at right angles. In all cases the edges of the connection should be flush and carefully smoothed.

Sectional Form.

17. Most sewer pipes have a circular section; some have an egg-shape section. For the same total capacity the circular section is the more economical one to manufacture. The egg-shape section, however, has an advantage over the circular one in a combined sewer system where there is a great difference in the quantity of ordinary daily and stormwater flows. It allows the ordinary daily flow to be carried in an approximately semi-circular section, which gives it a greater velocity and more complete removal than when this ordinary flow is spread out over the bottom of a circular sewer which would give it greater resistance and facility for deposit. The egg-shape section, therefore, needs to have its radii properly proportioned to be of the best service for a combined sewer.

Permissible Variation from True Form.

18. The complete and rapid discharge of sewage is affected, more or less, also by an imperfect form of the sewer pipes, caused by inaccurate dimensions, irregular shape, eccentricity of molds, their improper matching, etc. It is important, therefore, that sufficient care should be given to these requirements in the manufacture of the pipe.

(*a*) *Imperfect Forms.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

(*b*) *Warping.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

(*c*) *Shrinkage.*—Discussion of this subject must await the report of the sub-committee to which it was referred.

Permissible Defects Relatin to Percolation and Leakage.

19. (*a*) *Porosity.*—The porosity of the pipe shell is generally negligible, so far as its effect is concerned, upon the complete and rapid delivery of sewage. The loss of water by leakage can only be slight through the pipe material. It is usually greatest through imperfectly made joints. The limitations, as regards porosity, required for strength and durability sufficiently cover the demands made under the present heading. No further tests are therefore required.

(*b*) *Cracks and Fractures.*—The effect of hair cracks and other cracks and fractures is also negligible under the present heading, when they satisfy the demands for strength and durability of the pipes already mentioned. Leakage through cracks consistent with stability will, in the cases of sewers, usually close up with solid material.

(*c*) *Joints and Jointing Materials.*—The joints of sewer pipes should be made with a material that secures tightness and elasticity. A number of such materials are now in use. The usual hub and spigot pipe should be provided with suitable corrugations and roughness of surface so as to allow the material to adhere thoroughly and firmly to the pipe. This, when done with a suitable material, will secure both tightness and elasticity.

The committee deems it unnecessary to refer to the various jointing materials when specifying sewer pipe.

(*B*) EASE AND ECONOMY OF HANDLING AND LAYING.

Equally important to fulfilling the essential purpose of a sewer pipe is the fulfilment of the conditions which arise in the delivery and laying of the pipe.

Toughness.

20. Pipes should therefore have a sufficient degree of toughness to stand the handling of loading and unloading, of conveyance to, and the placing into final position in the trench.

The toughness can best be measured by the impact of a falling body under definite conditions. In section 7, the committee recommended certain tests which it considered sufficient to secure the toughness necessary for the required strength of pipe. It considers those tests sufficient to guarantee the toughness required for the usual handling and laying of the pipe.

Weight.

21. Discussion of this subject must await the report of the sub-committee to which it was referred.

Length of Straight Pipe and Specials.

22. The joining of pipes to form a sewer is not only an item of expense in the making, but each joint also contributes some degree of resistance to the sewage flow and may invite some retention of solid matter. It is therefore desirable to reduce the number of joints as much as practicable, which means to correspondingly increase the length of the individual pipes.

But the greater this length, the greater becomes also the cost of making and handling the pipes per unit foot.

Form of Base.

23. Discussion of this subject must await the report of the sub-committee to which it was referred.

Ends of Pipe.

24. Discussion of this subject must await the report of the sub-committee to which it was referred.

Materials Used for Jointing.

25. Discussion of this subject must await the report of the sub-committee to which it was referred.

SECOND CLASS OF DATA: PRACTICAL EXAMINATIONS AND TESTS TO SECURE MATERIALS AND MANUFACTURE OF PIPE ANSWERING THE FOREGOING DEMANDS.

IV. EXAMINATIONS LIMITED TO OBSERVATIONS BY THE SENSES, CRUDE MEASUREMENTS, AND CRUDE FORCES (MOSTLY MILL AND FIELD).

(*A*) CLAY PIPE.

Identification o Clay Pipe.

26. For the purpose of identification, vitrified clay sewer pipe should bear the initials of the person, company or corporation by whom it is manufactured, the location of the mill and a suitable mark or sign indicating the class (standard or double-strength) to which it belongs, all indented plainly on the outer surface of the barrel near the bell, before vitrification. The following mark or insignia indicating that it is manufactured in accordance with the American standard (American Society for Testing Materials) should also be indented on the outer surface just below the first-mentioned marks:

Insert mark or insignia here.

Examination of Material for Clay Pipe.

27. (*a*) To determine whether the pipe material is uniform in character, free from cinder and interior structural defects, pieces broken from various parts of the pipe barrel and bell should be examined by the engineer in the field. The defects which can be observed in clay pipe are laminations, blisters, fire cracks, lack of uniformity of material, incompleteness of vitrification, and adulterants such as cinders or pebbles which do not unite in vitrification with the clay, etc.

(*b*) If, in the judgment of the engineer, the pipes broken in handling do not furnish sufficient opportunity to ascertain the character of the material of which they are made and the excellence of manufacture, one pipe in every 200, in addition to those selected for laboratory tests and those which are rejected as plainly defective, may be selected by the engineer and broken for the purpose of observation. The number of pipe so selected should be increased if the brand of pipe is not well known, or is not in common or frequent use in the locality. The selection must be left to the judgment of the engineer.

True Sectional Form and Dimensions of Clay Pipe.

28. (*a*) The sectional form and dimensions of pipe should be determined by measurement of at least two internal diameters, at right angles to each other at the end of the barrel and in the bell. The thickness of shell and bell, length, depth of bell, etc., should also be measured.

(*b*) The internal diameter of the barrel and the bell should at no place vary from the standard dimensions by a greater amount than that given in Table V.

The permissible variation from other standard dimensions, for all sizes, should not be greater than the following: Length, $\frac{1}{4}$ in.; depth of bell, 5 per cent of standard.

(*c*) To determine compliance with the standard the engineer may measure in the field or at the mill any proportion of the pipes furnished for use that he considers necessary.

Warping of Clay Pipe.

29. (*a*) A warp in a pipe shall be considered and measured as being the maximum perpendicular distance from a straight edge to the inside surface of the pipe. The straight edge should rest upon the ends of the barrel of the pipe and the measurement should be taken on the concave side of the curve.

(*b*) The permissible limits of warp or the variation from the straightness of the barrel, when measured as above, shall be as given in Table VI.

(*c*) To determine compliance with the standard the engineer may measure in the field or at the mill, any proportion of the pipes furnished for use that he considers necessary.

Uniform Thickness of Shell of Clay Pipe.

30. (*a*) The thickness of a shell of a pipe should be determined by at least four measurements about the circumference, not less than 6 in. from each end. More measurements

should be made if from the appearance of the pipe the engineer considers it necessary.

(*b*) The shells of pipes at any point should not vary in thickness from the figures given in Section 11 (Table III), by amounts greater than the figures given in Table VII.

TABLE VI.—PERMISSIBLE LIMITS OF WARP OF CLAY PIPE.

Length of Pipe.	Permissible Warp, in.
2 ft., 0 in................	$\frac{3}{16}$
2 ft., 6 in................	$\frac{1}{4}$
3 ft., 0 in................	$\frac{5}{16}$
4 ft., 0 in................	$\frac{3}{8}$

The permissible limits of variation in the thickness of bells should be the same as those for shells.

(*c*) To determine compliance with the standard, pipes furnished for use may be measured in this manner in the field or at the mill to any extent thought necessary by the engineer.

TABLE VII.—PERMISSIBLE VARIATIONS IN THICKNESS OF CLAY AND CEMENT-CONCRETE PIPE.

Diameter of Pipe, in.	Permissible Variation in Thickness of Shell, in.
To 12, incl.............	$\frac{1}{16}$
13 to 20 incl...........	$\frac{3}{32}$
21 to 30, incl...........	$\frac{1}{8}$
31 to 42, incl...........	$\frac{3}{16}$

Vitrification of Clay Pipe.

31. (*a*) The degree of vitrification may be judged by the appearance of the fracture of a broken pipe. This fracture should be conchoidal; the edges should be sharp and the surface smooth. The uniformity of vitrification may be judged by the uniformity of color and hardness of fractured surfaces.

(*b*) The permissible limits of variation in degree of vitrification or brittlement due to supervitrification cannot be satisfactorily determined by observations at the mill or in the field. Such observations can only determine the more obvious variations from permissible limits, such as very slight or very complete vitrification. Permissible limits are more satisfactorily determined by other qualities which are largely dependent upon degree of vitrification, such as toughness, porosity, etc., which may be better measured by the more exact laboratory tests.

(*c*) No rule can be established as to the proportion of pipes delivered for use which should be examined in the field or at the mill to determine the degree and uniformity of vitrification. After examination of pieces of a few specimens, the engineer can usually form a reasonably correct opinion as to the uniformity of vitrification and thoroughness of burning, by observing the uniformity of color and other characteristics.

Fractures of Clay Pipe.

32. (*a*) Fractured pipes—that is, those from some portion of which pieces have been broken—are easily detected by simple observation.

(*b*) Pipes from which pieces are broken from the barrel, if the remaining portions are not injured, may properly be used for closures or for spurs in masonry after the broken portions are cut away. If the fracture does not extend through the shell, and consists only of the removal of small pieces in such a way that the strength is not affected and the inside surface is not broken, rejection is not warranted. This is especially true if the pipes are laid in a concrete cradle so that the injured portions may be buried in concrete. Small pieces broken from the bell are not sufficient cause for rejection, if the fracture is of such a nature that it can be laid at the top of the sewer and thoroughly covered with mortar, or on the lower half of the circumference if buried in a concrete cradle. No exact limits in such cases can be fixed. By the observation of a few guiding rules such as the above, reasonable uniformity of judgment can be secured.

(*c*) All pipes used should be carefully observed for fractures.

Cracks Passing through Shell of Clay Pipe.

33. (*a*) Cracks passing through the shell are readily detected by tapping with a hammer. The difference in the character of sound emitted by whole pipe and cracked pipe, when tapped with a hammer, is very noticeable.

(*b*) The use of cracked pipe in sewer work is not permissible under ordinary conditions.

(*c*) Every pipe used should be carefully observed and tapped to determine the existence of cracks, immediately before it is laid in the sewer.

Laminations in Clay Pipe.

34. (*a*) The extent of laminations can best be judged by the examination of pieces broken from pipes. The presence of laminations may often be detected by sounding with a hammer.

(*b*) The permissible limits cannot be expressed as degrees of lamination, and compliance with an exact requirement cannot be determined from a field inspection. The best specifications require that pipes shall not contain laminations detrimental to strength or durability. The permissible limits are left to the judgment of the engineer or the requirements of other more exact laboratory tests.

(*c*) A sufficient number of pipes should be observed to satisfy the engineer that the pipes delivered for use are reasonably uniform in this respect and do not contain laminations sufficient to impair strength and durability. If there is a noticeable absence of lamination, and if pipes are uniform in character, it is necessary to observe only a few specimens. If, on the other hand, they are not uniform in character and contain a high degree of lamination, a greater number of samples should be observed. No fixed rule can be established.

Fire Cracks in Clay Pipe.

35. (*a*) The extent and frequency of fire cracks can be satisfactorily determined by careful inspection in the field.

(*b*) The permissible limits cannot be exactly specified. Fire cracks should not be so extensive or frequent as to impair the strength of the pipe. They should not extend through the shell of the barrel, but in a few cases may be allowed to extend through the shell of the bell. This is a matter that must be left to the judgment of the engineer, so far as field tests are concerned.

(*c*) All pipes used should be carefully inspected to determine the extent of the existence of fire cracks.

Blisters and Protuberances in Clay Pipe.

36. (*a*) The existence of protuberances and blisters is easily detected by ordinary inspection. They can be described by their area and height or by the percentage of the area of

the whole pipe covered by them and the ease with which they can be broken.

(*b*) The inner surfaces of pipes should be substantially free from blisters and protuberances. They may be permitted, in small numbers, on the outer surfaces if they are not sufficiently numerous to impair the strength of the pipes and are tough and strong enough to resist blows from handling and laying, and from loads to which they are subjected in the trench. The extent to which they are allowable cannot be exactly expressed, but must be left to the judgment of the engineer guided by a few simple rules as above.

(*c*) All pipes furnished for use should be carefully inspected to determine the character and frequency of blisters and protuberances.

Glazing of Clay Pipe.

37. (*a*) Inspection in the field should determine whether the glazing is continuous over the entire surface, except the inside surface of the bell and the outside surface of the spigot, if so specified, whether it is punctured by fusing out of the iron ingredients of the clay, and whether it is of a substantial thickness and adheres to the clay so as to become an integral part of the pipe body.

(*b*) Small defects in glazing, such as roughness of surface, punctures caused by fusing out of iron from the clay, or small injuries caused by handling, are permissible, if they occur on the outside surface. The glazing on the inside should be smooth, continuous and practically without defect.

(*c*) Every pipe should be inspected to determine the character of the glazing.

Toughness of Clay Pipe.

38. (*a*) Toughness as measured by the resistance to abrasion cannot be accurately determined by an inspection in the field. Such a test requires laboratory apparatus. Some idea of the toughness of a pipe can be obtained by an experienced inspector by its behavior under the blows of a hammer and when worked and trimmed with chisel and hammer. Such a test as this may be satisfactorily made with a piece of pipe broken for other purposes. If no laboratory is available it is practicable to carry out regular impact tests in the field.

(*b*) The required toughness should be expressed as resistance to the blows of a given weight falling from a specified height.

(*c*) If the pipes delivered for use are fairly uniform in character, and are the product of a single factory, it is sufficient to test 2 per cent of all pipe delivered in this manner. If they are not uniform in character, the proportion tested should be left to the judgment of the engineer.

Ends of Clay Pipe.

39. (*a*) The ends of pipes should be inspected in the field to determine their compliance with specification requirements as to depth of bell, internal diameter of bell, external diameter of spigot, thickness of bell, glazing and scoring on the inside of bell and outside of spigot, general finish and shape.

(*b*) Small defects which do not affect the strength or durability of the pipes or the smoothness of the inside of the sewer, such as small chips from or fire cracks in the bell or the outside of the spigot, slight warp or deviations from true form which do not materially interfere with the making of joints, and other minor defects of this character, are in some cases permissible. There should be substantial compliance with specification requirements.

(*c*) All pipes delivered for use should be inspected in the field to determine the dimensions, finish, perfection, etc., of the ends.

Angles and Secure Attachment of Branch Pieces of Clay Pipe.

40. (*a*) It is usually not necessary or practicable to secure absolute accuracy in the angle of attachment of branches and spurs. It is possible for an experienced person to determine whether this angle is accurate within 5 deg. The strength and character of the attachment can be judged by putting a strain on the branch piece and by light blows from a hammer or other weight.

(*b*) A variation of not more than 5 deg. from the true angle is permissible.

(*c*) Slight defects in angle of attachment and finish of outside surface which do not affect the strength of the joint, smoothness of the inside surface or the evenness of joint are permissible.

(*d*) Every branch and spur pipe furnished for use should be inspected to determine the compliance with specification requirements.

(*B*) CEMENT-CONCRETE PIPE.

Identification and Age of Cement-Concrete Pipe.

41. (*a*) For the purpose of identification and adaptability to its proposed use, cement-concrete pipe should bear the initials of the person, corporation or concern by whom it is manufactured, the location of the plant and the date of manufacture.

It should also bear the following mark or insignia indicating that it is manufactured in accordance with the American standard (American Society for Testing Materials):

Insert mark or insignia here.

(*b*) All these marks should be plainly indented on the outer surface of the barrel near the bell or on some portion of the inside surface of the bell which is exposed after the molding of the pipe is completed and before the forms have been removed.

Examination of Materials of Cement-Concrete Pipe.

42. (*a*) To determine whether the pipe material is uniform in character, free from deleterious ingredients and interior structural defects, pieces of pipes broken from various parts of the barrel and the bell should be examined by the engineer in the field. The defects which can be observed in cement-concrete pipe are character and uniformity of mixture of aggregates, compactness, etc.

(*b*) If, in the judgment of the engineer, the pipes broken in handling do not furnish sufficient opportunity to ascertain the character of the material of which they are made and the excellence of manufacture, one pipe in every 200, in addition to those selected for laboratory tests and those which are rejected as plainly defective, may be selected by the engineer and broken for the purpose of observation. The number of pipes so selected should be increased if the brand of pipe is not well known or is not in common or frequent use in the locality. The selection must be left to the judgment of the engineer.

True Sectional Form and Dimensions of Cement-Concrete Pipe.

43. (*a*) The sectional form and dimensions of pipes should be determined by measurement of at least two internal diameters, at right angles to each other, at each end of the barrel and in the bell. The thickness of shell and bell, length, depth of bell, etc., should also be measured.

(*b*) The internal diameter of the barrel, and the bell should at no place vary from the standard dimensions by a greater amount than that given in Table VIII.

The permissible variation from other standard dimensions, for all sizes, should not be greater than the following: Length, $\frac{1}{4}$ in.; depth of bell, 5 per cent of standard.

(*c*) To determine compliance with the standard, the engineer may measure in the field or at the mill any proportion of the pipes furnished for use that he considers necessary.

Uniform Thickness of Shell of Cement-Concrete Pipe.

44. (*a*) The thickness of a shell of a pipe should be determined by at least four measurements about the circumference not less than 6 in. from each end. More measurements should be made if from the appearance of the pipe the engineer considers it necessary.

TABLE VIII.—PERMISSIBLE VARIATIONS FROM STANDARD DIAMETER OF CEMENT-CONCRETE PIPE.

Standard Internal Diameter of Pipe, in.	Permissible Variation from Standard, in.
To 15, incl.	$\frac{3}{16}$
16 to 30, incl.	$\frac{1}{4}$
31 to 42, incl.	$\frac{5}{16}$

(*b*) The shells of pipes at any point should not vary in thickness from the figures given in Section 11, by amounts greater than the figures given in Table VII.

The permissible limits of variation in the thickness of bells should be the same as those for shells.

(*c*) To determine compliance with the standard the engineer may measure in the field or at the mill any proportion of the pipes furnished for use that he considers necessary.

Smoothness of Interior Surface of Cement-Concrete Pipe.

45. (*a*) The degree of smoothness of the interior surface of cement-concrete pipe can only be determined by appearances from any examination that it is practicable to make in the field or in the mill. There is no exact rule or standard by which this can be measured.

(*b*) The inside surface of cement-concrete pipe should be comparable in smoothness to that of a plastered wall or troweled surface of a cement walk. It is not practicable to specify an exact degree of allowable roughness.

(*c*) The character of the interior surface of practically all of the pipes delivered for use should be observed.

Security and Uniformity of Artificial Linings and Coatings of Cement-Concrete Pipe.

46. (*a*) In a great majority of cases artificial linings and coatings in cement-concrete pipe have heretofore served no useful purpose. Linings are expensive. The purpose to be accomplished by their use can be accomplished more economically and perfectly by the use of vitrified clay pipe. Coatings, though cheap, are not durable and do not accomplish the purpose for which they are designed.

If, under special circumstances, it is necessary to use them, careful observation in the field or at the mill is desirable to determine their uniformity and smoothness of surface, the security of attachment to the shell of the pipe, the character of the joints between the sections or pieces of which the lining is composed, the extent to which coating material has penetrated and adheres to the concrete, and the uniformity with which it has been spread upon the surface.

(*b*) No defects in linings are permissible, such as rough, uneven or wide joints; roughness of surface caused by warping or irregularity in shape of sections of lining material, cracks, protuberances, etc.

Such defects as are permissible in the inside surfaces of cement-concrete or vitrified clay pipes, are permissible in lining and lining materials.

No defects in coating, such as poor adherence to the concrete, causing peeling, blistering, cracking, etc., lack of uniformity in application, solubility in weak acids or alkalies, etc., or disintegration from their effects, are permissible.

(*c*) All pipes furnished for use should be carefully observed to determine the existence of the above defects in coating and lining materials.

Fractures of Cement-Concrete Pipe.

47. (*a*) Fractured pipes—that is, pipes from some portion of which pieces have been broken—are easily detected by simple observation.

(*b*) Pipes from which pieces are broken from the barrel, if the remaining portions are not injured, may properly be used for closures or for spurs in masonry after the broken portions are cut away. If the fracture does not extend through the shell, and consists only of the removal of small pieces in such a way that the strength is not affected and the inside surface is not broken, rejection is not warranted. This is especially true if the pipes are laid in a concrete cradle so that the injured portions may be buried in concrete. Small pieces broken from the bell are not sufficient cause for rejection if the fracture is of a nature that it can be laid at the top of the sewer and thoroughly covered with mortar, or on the lower half of the circumference if buried in a concrete cradle. No exact limits in such cases can be fixed. By the observation of a few guiding rules, such as the above, reasonable uniformity of judgment can be secured.

(*c*) All pipes used should be carefully observed for fractures.

Cracks Passing Through Shell of Cement-Concrete Pipe.

48. (*a*) Cracks passing through the shell are readily detected by tapping with a hammer. The difference in the character of sound emitted by whole pipe and cracked pipe, when tapped with a hammer, is very noticeable.

(*b*) The use of cracked pipe in sewer work is not permissible under ordinary conditions.

(*c*) Every pipe used should be carefully observed and tapped to determine the existence of cracks immediately before it is laid in the sewer.

Hair Cracks in Cement-Concrete Pipe.

49. (*a*) The extent of hair cracks, being only surface defects, can satisfactorily be determined by simple observation in the field. Tapping with a hammer will show, by scaling or crumbling under the blows, whether their presence indicates damaged or inferior ingredients, their improper manipulation or improper methods of curing.

(*b*) Hair cracks in themselves are not greatly objectionable if their presence in great numbers does not indicate other and more vital defects, such as small resistance to internal or external pressure, scaling of surface, coatings or washings put on for the purpose of covering up surface defects, etc. Their permissible limits cannot be exactly expressed but must be left to the judgment of the engineer.

(*c*) All pipes delivered for use should be observed to determine the extent of hair cracks.

Toughness of Cement-Concrete Pipe.

50. (*a*) Toughness, as measured by resistance to abrasion, cannot be accurately determined by an inspector in the field. Such a test requires laboratory apparatus. Some idea of the toughness of a pipe can be obtained by an experienced inspector from its behavior under the blows of a hammer and when worked and trimmed with chisel and hammer. Such a test as this may be satisfactorily made with pieces of pipe broken for other purposes. If no laboratory is available it is practicable to carry out regular impact tests in the field.

(*b*) The required toughness should be expressed as resistance to the blows of a given weight falling from a specified height, and should be such as to permit working and trimming accurately with chisel and hammer.

(*c*) If the pipes delivered for use are fairly uniform in character, and are the product of a single factory, it is sufficient to test 2 per cent of all pipe delivered in this manner. If they are not uniform in character the proportion tested should be left to the judgment of the engineer.

Ends of Cement-Concrete Pipe.

51. (*a*) The ends of pipes should be inspected in the field to determine their compliance with specification requirements as to depth of bell, internal diameter of bell, external diameter of spigot, thickness of bell, general finish and shape.

(*b*) Small defects which do not affect the strength or durability of the pipes or the smoothness of the inside of the sewer, such as small chips from or hair cracks in bell or outside of spigot, slight deviation from true form and dimensions which do not materially interfere with the making of joints, are in some cases allowable. There should be substantial compliance with specification requirements in all these particulars.

(*c*) All pipes delivered for use should be inspected in the field to determine the dimensions, finish, perfection, etc., of the ends.

Angles and Secure Attachment of Branch Pieces of Cement-Concrete Pipe.

52. (*a*) It is not usually necessary or practicable to secure great accuracy in the angle of attachment of branches and spurs. It is possible for an experienced person to determine whether this angle is accurate within 5 deg. The strength and

character of the attachment can be judged by putting a strain on the branch piece and by light blows from a hammer or other light weight.

(*b*) A variation of not more than 5 deg. from the true angle is permissible.

(*c*) Slight defects in angle of attachment and finish of outside surface, which do not affect the strength of the joint, smoothness of the inside surface or the unevenness of joints, are permissible.

(*d*) Every branch and spur pipe furnished for use should be inspected to determine the compliance with specification requirements.

V. TESTS DETERMINING PROPERTIES BY METHODS AND APPARATUS TO MEASURE THE EFFECTS OF PHYSICAL AND CHEMICAL FORCES (MOSTLY LABORATORY).

(*A*) SPECIAL PHYSICAL AND CHEMICAL TESTS OF MATERIALS.

53. Clay should be tested from time to time or whenever the character of any of the various ingredients which go to make up the complete pipe material or mixture changes, so that the properties of the finished product may be affected. **Clay.**

54. Cement should be tested frequently and under the conditions required by the Standard Specifications and Tests for Portland Cement (Serial Designation: C-9) of the American Society for Testing Materials. **Cement.**

55. A number of representative samples of sand should be tested when the first quantity is delivered at the mill for use in the manufacture of pipes, and thereafter whenever new batches are delivered or when its character as to fineness, cleanness or character of grains changes perceptably. **Sand.**

(*a*) *Physical Tests.*—Sand should be free from particles which will pass a 200-mesh sieve and will be retained on a 4-mesh sieve. It should contain no organic matter or material the strength of which is less than the cement used. It should be sharp and preferably of a silicious nature.

Sand should be tested to determine its fineness and cleanness or sharpness, freedom from loam, clay, mica and organic or other impurities which impair the strength or durability of the finished product.

The test for fineness is best made with sieves having meshes of such sizes as are necessary to satisfy the requirements of Section 4 (*b*).

The test for sharpness should be made with a magnifying glass.

The test for cleanness should be made: (1) by determining the loss of weight in a sample after it is subjected to an incinerating temperature indicating the amount of organic matter present; (2) by inspection under a microscope to determine the quantity of mica present; and (3) by determining the loss of weight after washing upon a fine sieve (say 100 meshes per inch) and drying, indicating the quantity of clay loam or other adulterant present.

(*b*) *Chemical Tests.*—If the character of the sand is such that a chemical analysis is necessary to determine whether it is mistaken for the purpose, this analysis should be in sufficient detail to identify the materials of which the sand is composed so that their strength, durability and serviceability may be judged.

Stone. 56. Stone should be tested when the first quantity is delivered at the mill for use in the manufacture of pipes, and thereafter whenever new batches are delivered or when its fineness, cleanness or character of grains changes perceptibly.

(*a*) *Physical Tests.*—Broken stone should be tested by sieves of the proper openings to determine compliance with the requirements of Section 4 (*c*) as to sizes specified for use in shells of various thickness.

Its hardness may be judged by its behavior under the blows of a hammer.

Its durability may be determined from the character of the mineral or minerals of which it is composed, or inspection of the exposed face of the quarry.

Its soundness and cleanness may be judged by simple inspection.

(*b*) *Chemical Tests.*—Chemical tests of broken stone are not necessary. This is assuming an ordinary knowledge of the characteristics of minerals.

Water. 57. (*a*) Potable water used in mixing concrete will usually require no test. If it is not potable it should be tested at least once to determine whether the impurities are objectionable for this purpose.

(*b*) Potability is a sufficient test of fresh clean water suitable for use in the manufacture of concrete. The chemical analysis necessary to determine the presence and strength of chemicals contained in water will depend upon the character of the chemicals.

Waterproofing Compounds.

58. (*a*) Waterproofing compounds should be carefully tested before use and from time to time thereafter to determine whether the properties continue uniformly.

(*b*) Waterproofing compounds which are valuable for use with vitrified clay sewer pipes should be tested to determine the melting temperature and the temperature at which they can be pounded freely, the strength of adhesion to glazed surfaces, and elasticity when cold. Adhesion to the pipe surface should not be broken by cooling.

They should be tested by submission for as long periods as possible in fresh and salt-water domestic sewage for at least a period of five days in a 1-per-cent solution of hydrochloric acid and a 5-per-cent solution of caustic potash. They should be tested for tightness under a water pressure of 20 lb. per sq. in.

(*B*) SPECIAL TESTS FOR CLAY PIPE.

Vitrification of Clay Pipe.

59. Inasmuch as a high degree of vitrification is always secured at the expense of toughness, the results of the special test for toughness will give some indication of the degree of vitrification.

Durability and serviceability increase with the completeness of vitrification so that the tests for strength and toughness will usually decide.

Possibly chemical treatment of some kind will give exact information as to the best degree of vitrification.

Familiarity with the appearance of properly vitrified clay will make it possible to form a correct opinion as to the excellence in this respect of samples to be tested.

Toughness of Clay Pipe.

60. (*a*) The degree of toughness of vitrified pipe is usually tested by its ability to withstand a given number of blows of a metal weight which is allowed to fall a given distance.

(*b*) A suitable standard of toughness is its ability to stand without injury three blows of a cast-iron ball weighing 8 lb. and falling 18 in. It should also have such toughness that it can be worked with a chisel and hammer.

Resistance of Clay Pipe to Abrasion.

61. (*a*) The degree of resistance to abrasion may be directly measured by test with a sand blast.

(*b*) Such tests should be made with a uniform or standard sand, uniform or standard air pressure and with standard nozzle held for a specified length of time at a given distance from a specimen or test piece of standard weight, shape and surface dimensions. The loss of weight will form a satisfactory basis of comparison.

Resistance of Clay Pipe to Rupture.

62. (*a*) *External Forces.*—The resistance to rupture of vitrified clay pipe is best determined by what is known as the knife-edge test; that is, by its ability to withstand certain pressures applied through a knife edge, say 1 in. in width, placed at the crown, parallel to the axis of the pipe and extending the whole length inclusive of the bell, and supported upon a similar knife edge at the bottom. These should be so placed that an even bearing is secured throughout the entire length. The pressures given in Table IX are recommended.

(*b*) *Internal Forces.*—Hydrostatic pressure applied to the inside of the pipe is undoubtedly the best test of its ability to resist rupture by internal forces.

Vitrified pipe should withstand an internal hydrostatic pressure such that the direct tension in the material is about 180 lb. per sq. in., or for a 12-in. pipe, shell 1 in. thick, a hydrostatic pressure of 30 lb. per sq. in.

Resistance of Clay Pipe to Disintegration.

63. (*a*) *By Acids.*—It is not necessary to carry out tests of this character, because proper vitrification and proper glazing of vitrified pipe which is satisfactory in other particulars, will be sufficient guarantee that acids found in sewage will not injuriously affect it.

(*b*) *By Alkalies.*—It is not necessary to carry out tests of this character, because proper vitrification and proper glazing of vitrified pipe which is satisfactory in other particulars, will be sufficient guarantee that alkalies found in sewage will not injuriously affect it.

(*c*) *By Steam.*—It is not necessary to carry out tests of this character, because proper vitrification and proper glazing of vitrified pipe which is satisfactory in other particulars, will be sufficient guarantee that steam found in sewage will not injuriously affect it unless steam is exhausted at high pressure. This is manifestly improper and should be prohibited.

(*d*) *By Frost.*—The susceptibility of vitrified pipe to the action of frost may be judged by its porosity. This may be determined by the standard test for absorption. A reasonable limit of absorption is 5.5 per cent by weight of water. The manner in which this test is carried out may be in accordance with the usual specification. Proper glazing is an additional protection against injury by frost.

TABLE IX.—PRESSURES FOR KNIFE-EDGE TEST OF CLAY AND CEMENT-CONCRETE PIPE.

Diameter of Pipe, in.	Pressure per Linear Foot to be Applied, lb.	Diameter of Pipe, in.	Pressure per Linear Foot to be Applied, lb.
6	900	22	1750
8	900	24	1950
10	1000	27	2150
12	1050	30	2350
15	1250	33	2500
18	1400	36	2800
20	1550	42	3200

Glazing of Clay Pipe.

64. The extent of the glazing can be determined by observation. The firmness with which the glazing is attached to the body of the pipe may be determined by the blows of a hammer or by its appearance when the pipe is so worked with a chisel and hammer.

Salt glazing is now the only kind in use so that tests to determine this are not necessary.

(C) SPECIAL TESTS FOR CEMENT-CONCRETE PIPE.

Age of Cement-Concrete Pipe before Testing.

65. Cement-concrete pipe should be manufactured at least 60 days before it is subjected to any of the following tests.

Compactness of Cement-Concrete Pipe.

66. The rate of percolation under hydraulic pressure of a given number of pounds per square inch is one practical test of compactness. At a pressure of 10 lb. per sq. in., pipe of all sizes should show no percolation. At a pressure of 15 lb. per sq. in. percolation should not exceed .... gallons per hour per square foot of inside surface.

The percentage of absorption is the most usual and practical test for compactness. Sample pieces of cement-concrete pipe when immersed in water after having been thoroughly dried, should not absorb more than 10 per cent of their weight of water.

Toughness of Cement-Concrete Pipe.

67. (*a*) The degree of toughness of cement-concrete pipe is usually tested by its ability to withstand a given number of blows from a metal weight which is allowed to fall through a given distance.

(*b*) A suitable standard of toughness is its ability to withstand without injury three blows from a cast-iron ball weighing 8 lb. and falling 18 in. It should also have such toughness that it can be worked with a chisel and hammer.

Resistance of Cement-Concrete Pipe to Abrasion.

68. (*a*) The degree of resistance to abrasion may be directly measured by a test with a sand blast.

(*b*) Such tests should be made with a uniform or standard sand, uniform or standard air pressure and with standard nozzle held for a specified length of time at a given distance from a specimen or test piece of standard weight, shape and surface dimensions. The loss of weight will form a satisfactory basis of comparison.

Resistance of Cement-Concrete Pipe to Rupture.

69. (*a*) *External Forces.*—The resistance to rupture of cement-concrete pipe is best determined by what is known as the knife-edge test; that is, by its ability to withstand certain pressures applied through a knife edge, say 1 in. in width, placed at the crown, parallel to the axis of the pipe and extending the whole length, inclusive of the bell, and supported upon a similar knife edge at the bottom. These should be so placed that an even bearing is secured throughout the entire length. The pressures given in Table IX are recommended.

(*b*) *Internal Forces.*—Hydrostatic pressure applied to the inside of the pipe is undoubtedly the best test of its ability to resist rupture by internal forces.

Cement-concrete pipe should withstand an internal hydrostatic pressure such that the direct tension in the material is about 180 lb. per sq. in., or for a 12-in. pipe, shell 1 in. thick, a hydrostatic pressure of 30 lb. per sq. in.

Resistance of Cement-Concrete Pipe to Disintegration.

70. (*a*) *By Acids.*—Cement-concrete pipe will disintegrate if in contact with liquids having acid reactions unless such reactions are very faint. They should, therefore, never be used under these conditions and tests are unnecessary.

(*b*) *By Alkalies.*—Sample pieces of pipe should be submerged in alkalies similar to those which occur in the sewage for as long a period as practicable. Upon removal the specimens should be observed for evidences of surface disintegration and loss of weight.

The action of strong solutions of such alkalies upon Portland cement may also be observed.

The alkalies present in ordinary domestic sewage do not effect cement-concrete pipe so that for use as carriers of domestic sewage no such tests are necessary.

(*c*) *By Steam.*—It is not necessary to carry out tests of this character if the cement has been properly tested unless steam is exhausted under pressure. This is manifestly improper and should be prohibited.

(*d*) *By Frost.*—The susceptibility of cement-concrete pipe to the action of frost may be judged by its porosity. This may be determined by the standard test for absorption. A reasonable limit of absorption is 10 per cent by weight of water.

Artificial Linings and Coatings of Cement-Concrete Pipe.

71. (*a*) The suitability of artificial linings for cement-concrete pipe may be judged or tested: (1) by the smoothness of interior surface which they produce; (2) by the firmness of their attachment to the body of the pipe; (3) by the liability to injury by handling, shipping, laying or cleaning; (4) by their durability in contact with alkalies, acids, domestic sewage and water; and (5) by their cost as compared with that of other kinds of pipe equally serviceable.

(*b*) Coatings for cement-concrete pipe are usually inexpensive. They present a sufficiently smooth surface and adhere firmly to the surface of the pipe.

They are most liable to failure from disintegration. The principal test to determine their suitability is, therefore, the one for durability.

(*D*) GENERAL TESTS FOR CLAY AND CEMENT-CONCRETE PIPES.

Porosity. 72. Porosity in the cases of both vitrified clay and cement-concrete pipes can best be tested by the tests for absorption and percolation, described under Section 6.

Such tests need only be carried out once for each contract of average size unless the character of the pipe furnished changes.

Resistance to Abrasion. 73. Tests to determine this quality should be made in a manner similar to that described in Section 60 (*a*).

Such tests need only be carried out once for each contract of average size unless the character of the pipe furnished changes.

REPORT OF COMMITTEE C-6

ON

DRAIN TILE.

Committee C-6 conferred with the Executive Committee of the Society at its October and January quarterly meetings, on the question of general policy as to references in drain-tile specifications to pipe-laying methods, which question was referred to the two committees by the Society at the 1915 annual meeting. An agreement has been reached by the two committees, to which reference will be made in the annual report of the Executive Committee to the Society.

Committee C-6 has proceeded with the work of revising and completing the present Standard Specifications for Drain Tile[1] in accordance with its agreement with the Executive Committee, the general plan and outline of the revised specifications having been approved by the Executive Committee at its quarterly meeting in January, 1916.

Committee C-6 has held two meetings of the full committee during the year, the first at Madison, Wis., December 10, 1915, at which 11 members of the committee were represented and 4 visitors were present, and the second at Chicago, Ill., April 28, 1916, at which 11 members were represented and 3 visitors were present. In addition, three meetings of sub-committees, appointed to do special work in the preparation of preliminary drafts of the revised specifications, were held.

At the second meeting of the committee, the revision and completion of the specifications were finally accomplished and they were sent to letter ballot with the following result: Affirmative, 12; negative, 2; not voting, none.

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[1] 1915 Year-Book, p. 378.

Accordingly, proposed revised Standard Specifications for Drain Tile are submitted herewith for consideration by the Society, with the recommendation that they be referred to letter ballot for adoption as standard.

The revised specifications have been very carefully compiled in such a manner as to conform closely to the general form of standard specifications of the Society. They include new specifications for standard absorption tests and freezing and thawing tests, and corresponding test requirements. In preparing these new specifications, the committee was fortunate in securing the cooperation of the testing laboratories of the University of Wisconsin, of the Lewis Institute, Chicago, Ill., of the Iowa State College, and of Prof. Edward Orton, Jr., of Columbus, Ohio, which laboratories placed at the disposal of the committee the results of extensive absorption and freezing and thawing tests of actual drain tile. The committee wishes to make special acknowledgment of the valuable services of Prof. M. O. Withey, of the University of Wisconsin. The committee believes that no such large mass of data of absorption and freezing and thawing tests of drain tile have ever before been available for use. Great care has been taken in studying and digesting the data on which the revised specifications are based.

At the meeting of December 10, vacancies in the membership of the committee, caused by the resignations of Messrs. P. H. Atwood and A. W. Gates, were filled by the election of Mr. J. J. Hammen of Spencer, Iowa, and Prof. Edward Orton, Jr., of Columbus, Ohio. Since the date of the Madison meeting, two vacancies have been caused in the membership of the committee, by the resignations of the American Concrete Institute and of the Municipal Testing Laboratory of St. Louis, represented by Mr. Mont Schuyler. These vacancies are not yet filled.

At the meeting held in Chicago on April 28, the biennial election of officers was held, with the following result:

Chairman.—A. Marston, Ames, Iowa.
Vice-Chairman.—A. N. Talbot, Urbana, Ill.
Secretary.—J. T. Stewart, University Farm, St. Paul, Minn.

This report has been referred to letter ballot of the committee, which consists of 14 members, of whom 12 have voted affirmatively, 1 negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

A. MARSTON,
Chairman.

J. T. STEWART,
Secretary.

EDITORIAL NOTE.

The proposed revisions of the Standard referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916. The Standard as thus revised appears in the 1916 Volume of A.S.T.M. Standards.

For Discussion on the report, see page 262.

DISCUSSION.

Mr. Schmitt. MR. F. E. SCHMITT.—The report of Committee C-6 on Drain Tile presents, I think, the most remarkable example of a revision of specifications within the history of the Society. The Standard Specifications for Drain Tile as they existed two years ago and one year ago were so radically different from the shape into which they have now been put that it seems to me the committee deserves special recognition for the work they did during the past year.

The specifications contain a few unusual points. The one I have particularly in mind relates to the fact that duplicate or alternative requirements are provided. That is exceptional in specifications. One set of clauses is based on a classification into three grades of pipe—Farm, Standard, and Extra Quality drain tile—and describes fixed strengths for these grades (Section 36). I should judge that in ordering or accepting under these clauses we would primarily order or decide according to the qualities and strengths specified for the three grades. But there is an alternative clause which prescribes certain pressures and strengths according to service, and this clause appears to read that the delivery will be satisfactory if it meets this clause alone, irrespective of the previously-fixed classification into three grades.

Will Mr. Marston explain why duplicate requirements are necessary and just how they will work out in practice?

Mr. Marston. MR. A. MARSTON (*Chairman of Committee C-6*).—The second requirement designated by Mr. Schmitt applies only to cases in which the manufacturer is required by the purchaser to guarantee his pipe against cracking in the ditch. The purchaser of pipe who specified merely Farm drain tile, Standard drain tile or Extra Quality drain tile, would receive material complying with the requirements in Table I, and Table II would not apply in his case; but the committee has found it to be the practice in many cases in tile-drain construction on public work, and especially in the case of tile of large size, to require (in some cases by bond) that the manufacturer guarantee the pipe against **Mr. Marston.** cracking in the ditch. The committee believes that certain injustices occur in the working out of that requirement, as when the manufacturer is made responsible for abuse of the pipe in laying, or in handling during construction. It was therefore thought necessary to make such an additional requirement definite. This was done by providing that when the manufacturer supplies pipe of the strengths specified in Table II his obligation to supply pipe which will not crack in the ditch shall be held to be discharged.

The strengths of the several classes of tile and the strengths required by Table II for different depths and widths of ditches do not run parallel; that is, many of the entries in Table II would not be met by any of the tile classes. In other words, even Extra Quality tile would not meet the requirements of Table II in certain cases of actual ditches. This table simply governs the case where the manufacturer is required to guarantee that his tile will not crack in the ditch. Thus, if an order should specify both the tile class and the ditch guarantee, either part of the obligation might become the controlling factor. If the strength required for Extra Quality pipe, for example, in case the manufacturer had agreed to supply that, was greater than would be the strength required, as shown by Table II, to actually carry the load without cracking in the ditch, the former would become the controlling obligation.

REPORT OF COMMITTEE C-9

ON

CONCRETE AND CONCRETE AGGREGATES.

During the past year the work of Committee C-9 has continued along the lines indicated in the report submitted to the Society at the annual meeting in 1915.[1] The sub-committees have been following the programs outlined. The work has developed satisfactorily and valuable information has been secured.

The committee feels, however, that it would be unwise at this time to draw conclusions or make definite recommendations, as the data at hand do not warrant this.

The present report, therefore, is simply one of progress and gives in a general way the scope of the work under the direction of the sub-committees including the various phases of the investigations now under way.

Laboratory Tests for Concrete and Laws of Mechanical Mixtures.—A study has been made, by the sub-committee on this subject, of the methods of preparing samples of concrete for test purposes in the laboratory. An extensive series of tests have been carried on during the past year and this work will be continued until sufficient data are accumulated to form definite conclusions.

Studies have been made to determine the effect of variations in mechanical mixtures of the aggregates used in concretes and mortars. Numerous samples of fine and coarse aggregate have been separated and re-combined in definite ways so that information might be secured which would indicate the effect of size of particles, grading, and the relation of the fine to the coarse aggregate. This work also will be continued during the coming year.

Relative Values of Various Strength Tests.—During the past year the sub-committee on strength tests has confined itself to the problem of establishing the relative reliability of various tests of strength for determining the suitability of sand for use in concrete. An extensive series of tests was laid out by the subcommittee and given to six laboratories which have been carrying out the plans. The work of these laboratories is greatly appreciated, and it is hoped that data will ultimately be secured through this service which will be of great value. The work as outlined has not yet been completed, although a number of reports have been received already on accomplishments effected thus far.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 173 (1915).

Impurities Affecting Fine Aggregates.—This work has been carried on at the Structural Materials Research Laboratory of the Lewis Institute, Chicago, by Mr. Oscar E. Harder under the direction of Mr. D. A. Abrams. Much of the work is in new fields and progress is necessarily slow. Certain relations between strength of sand mortars and certain impurities appear to be indicated. A method for determining the presence of injurious impurities is being developed. The work done may be summarized as follows:

A rather extensive study has been made of the literature relating to fine aggregates and other subjects which seemed to be of importance in this investigation.

A chemical laboratory has been equipped and is being used exclusively for these researches. Some of the more important laboratories which are conducting researches along this and related lines have been visited and inspected.

Preliminary experiments on the determinations of the time of setting of cements by means of the temperature gradient have been made. These experiments indicate that such a method may be used to study the effect of various admixture on the time of setting of cements and mortars.

A study has been made of the various methods which have been used for the determination of silt in sands. A method has been adopted which gives consistent results and makes it possible to retain the silt and the wash-water. Chemical analysis of silts from ten sands have been completed. Analysis of silts from four other sands are in progress No definite conclusions have yet been drawn from these analyses.

It has been shown that a fairly consistent relation exists between the mortar-making properties of sands and the color produced by digesting them with a 3-per-cent solution of sodium hydroxide. By sieving the sands and then re-combining the different portions so that all the sands had practically the same grading, still more definite relations have been shown to exist between the color produced by digesting the sands with a 3-per-cent solution of sodium hydroxide and their mortar-making properties.

A number of sands have been extracted with dilute alkali and some of the extracts have been analyzed. It seems desirable to secure larger samples of these extracts and to make more detailed analyses. Studies are being made of the effect of additions of alkali extracts to normal sands.

Tests are being made to determine the effect of mica on the tensile and compressive strength of sand mortars.

Work is in progress which is expected to show the effect on the strength of sand mortars of coating the sands with various organic compounds. Tannic acid, gelatine, sugar, rosin and manure extract have been used for this purpose.

A carefully planned program has been outlined for the continuation of the work on thorough and broad lines to determine the impurities which are injurious, their detection and practical remedial measures.

Methods of Tests for Voids, Weights, Density, Specific Gravity, and Consistency.—The work as outlined in the 1915 report has been carried on during the past year and further systematic investigations have been made including methods of determining the weight per cubic foot of fine aggregate, using the cone method in the hands of five operators The results of these tests will be compared with the results obtained with the seven other methods previously outlined.

The results of the investigation of weight per cubic foot have been completely tabulated and curves drawn to indicate graphically the trend of the results obtained. Some further investigation is necessary before a definite recommendation as to standard method can be made.

Tests of specific gravity by use of the Le Chatelier bottle, the Jackson apparatus, a common graduated cylinder and several other methods have been started and returns are in from several laboratories. When sufficient data are accumulated the results will be tabulated and definite recommendations made.

Available Aggregates for Concrete.—A systematic investigation has been in progress during the past year to determine the location of suitable concrete aggregates. A considerable amount of information has been collected and tabulated. The assistance of the U. S. Geological Survey has been secured and much valuable service in this connection rendered. Work will continue along the present lines during the coming year.

Appreciation.—The committee wishes to express its appreciation of the valuable assistance provided by the various laboratories which have been carrying on the tests laid out by the committee. The laboratories of the following institutions are thus cooperating with the committee:

Massachusetts Institute of Technology, Boston, Mass.; University of Wisconsin, Madison, Wis.; Iowa State College, Ames, Iowa; Ohio State University, Columbus, Ohio; Philadelphia Testing Laboratories, Philadelphia, Pa.; University of Texas, Austin, Tex.; U. S. Office of Public Roads and Rural Engineering, Washington, D. C.; Public Service Commission, New York City; Columbia University, New York City; Lehigh University, So. Bethlehem, Pa.; Pittsburgh Testing Laboratory, Pittsburgh, Pa.; Westinghouse Church Kerr & Co. Laboratory, New York City; New England Bureau of Tests, Boston, Mass.; Lewis Institute, Chicago, Ill.; University of Illinois, Urbana, Ill.; Harvard University, Cambridge, Mass.; Kansas State College, Manhattan, Kans.; University of California, Berkeley, Cal.; Oregon Agricultural College, Corvallis, Ore.; Lafayette College, Easton, Pa.; Robert W. Hunt Engineering Co. Laboratory, Chicago, Ill.; University of Cincinnati, Cincinnati, Ohio; Carnegie Institute of Technology, Pittsburgh, Pa.; Colorado School of Mines, Golden, Colo.

The committee also desires to express its appreciation to those who so generously have contributed funds to aid in the prosecution of these tests and materials which have been distributed to the various laboratories.

This report has been submitted to letter ballot of the committee, which consists of 21 members, of whom 18 have voted affirmatively, none negatively, and 3 have refrained from voting.

Respectfully submitted on behalf of the committee,

SANFORD E. THOMPSON,
Chairman.

LEWIS R. FERGUSON,
Secretary.

REPORT OF COMMITTEE C-11

ON

GYPSUM AND GYPSUM PRODUCTS.

Committee C-11 has held three meetings during the year and the sub-committees have each held several meetings. The efforts of the committee have been directed to the preparation of tentative standards, which is somewhat difficult for the reason that few general specifications for gypsum and gypsum products are now in use, although the industry is an old and large one. While the committee has prepared several tentative specifications for gypsum and gypsum products, it does not feel that they should be published at this time.

The committee recommends that the proposed Tentative Definitions of Terms Relating to the Gypsum Industry, appended to this report,[1] be received and published as tentative in accordance with the usual practice. The need of definitions for gypsum products, as well as for all classes of plaster, stucco, mortar, cement and their various constituent materials, is admitted to be great. That confusion exists as to what is meant when any one of these terms is used, is evident to all who prepare or use specifications containing these terms. An examination of the literature published by manufacturers of these materials shows a perplexing confusion as to what the different materials should be called. The responsibility for this confusion must be shared generally by all those who use these terms and can only be removed by the cooperation of the various users, producers, professions, societies, and trades interested.

As a basis for discussion, Sub-Committee V on Nomenclature, Mr. S. G. Webb, Chairman, has prepared an outline based on the various forms and functions of gypsum and its products, which has been used to develop a glossary of names and definitions of these products and their ingredients, including a list of terms the use of which should be discontinued.

The functions and uses of gypsum are more or less similar to those of several other materials, and many of these similar materials and others are used in gypsum products. In preparing these recommendations, it was found necessary to correlate the nomenclature which has been adopted by other committees. This has been done so far as possible and where consistent with the basis of argument adopted by Sub-Committee V.

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[1] These Tentative Definitions appear on pp. 452–471.—Ed.

Other committees of the Society in the field covered by these definitions, namely, Committees C-1, C-2, C-4, C-5, C-6, C-7, C-9, D-1 and D-4, are therefore requested to consider the proposed Tentative Definitions in so far as they contain definitions cognate to their work, and to favor Committee C-11 with their criticisms and comments thereon.

Many of the definitions, both in the outline and in the glossary of terms, are yet to be supplied. By next year the committee hopes to have many of the definitions in complete form.

This report has been submitted to letter ballot of the committee, which consists of 28 members, of whom 23 have voted affirmatively, none negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

R. J. WIG,
Chairman.

L. I. NEALE,
Secretary.

EDITORIAL NOTE.

The report of Committee C-11, as presented at the annual meeting, included—in addition to the Tentative Definitions of Terms Relating to the Gypsum Industry—Tentative Specifications for Uncalcined and Calcined Gypsum, Tentative Specifications for Gypsum Plasters, and Tentative Methods for Testing Gypsum and Gypsum Products. At the request of the committee the entire report, except that published here, was referred back to the committee.

The Tentative Definitions were accepted for publication and appear on pages 452–471. In this connection the committee was instructed to embody in a future report, when the definitions will be subject to final action, (1) reasons for including definitions which apparently do not logically belong in the field of gypsum, and (2) specific and detailed reference to the definitions of cement and concrete in their present or revised form.

REPORT OF COMMITTEE D-1

ON

PRESERVATIVE COATINGS FOR STRUCTURAL MATERIALS.

Committee D-1, which now has 86 members, has held two meetings during the past year. At the meeting held November 13, 1915, 27 members were present and at the meeting held April 26, 1916, 38 members were in attendance.

The committee recommends for submission this year to letter ballot of the Society for adoption:

Proposed Revisions of the Standard Specifications for Purity of Raw Chinese Wood Oil:[1] D 12–15 (see Report of Sub-Committee III).

The committee further recommends that the following proposed tentative methods of test be published among the "Tentative Standards" of the Society, with a view of eliciting critical discussion:

1. Tentative Tests for Distillation of Paint Thinners Other than Turpentine, comprising the distillation test published last year[2] and the specific-gravity test offered this year (see Report of Sub-Committee XI);

2. Tentative Tests for Shellac, consisting of (*a*) Determination of Rosin in Shellac, and (*b*) Determination of Insoluble Matter in Shellac, published in 1914;[3] and (*c*) Determination of Moisture in Bleached Shellac, published during the past year as tentative.[4]

3. Tentative Methods for Routine Analysis of White Pigments,[5] which were published during the past year as tentative.

The committee further recommends that the first two of the above-mentioned tentative standards be published as part of the reports of the respective sub-committees in addition to being published among the "Tentative Standards," in the Year Book.[1]

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[1] 1915 Year-Book, p. 423.

[2] *Ibid.*, p. 567.

[3] Report of Sub-Committee XIII, of Committee D-1, on Shellac, *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, pp. 345 and 348 (1914).

[4] 1915 Year-Book, p. 571.

[5] *Ibid.*, p. 579.

Detail reports are appended from the following sub-committees:

Sub-Committee III on Testing of Paint Vehicles;
Sub-Committee V on Linseed Oil;
Sub-Committee XI on Paint Thinners Other than Turpentine;
Sub-Committee XIII on Shellac;
Sub-Committee XIV on Preparation of Iron and Steel Surfaces for Painting.

Sub-Committee X on Inspection of White-Paint Test Fence at Washington, D. C., has been discharged after reporting that the tests have been discontinued and the painted panels discarded.

The remaining sub-committees on technical subjects have submitted reports of progress.

In order to avoid confusion a number once assigned to a standing sub-committee is not given to another sub-committee even though that first sub-committee be discharged, unless another one on practically the same subject be later appointed. The following statement gives the present status of the various sub-committees:

Sub-Committee I, Advisory Committee: Active; renders no formal report, since its work is concerned only with the internal affairs of the whole committee.

Sub-Committee II on Inspection of Havre de Grace Bridge: Discharged in 1915.

Sub-Committee III on Testing of Paint Vehicles: Active; report appended.

Sub-Committee IV on Inspection of Steel Plates at Atlantic City: Discharged in 1915.

Sub-Committee V on Linseed Oil: Active; report appended.

Sub-Committee VI on Definition of Terms Used in Paint Specifications: Active; progress report.

Sub-Committee VII on Accelerated Tests and the Influence of Pigments on Corrosion: Active; progress report.

Sub-Committee VIII on Methods of Analysis of Paint Materials: Active; progress report.

Sub-Committee IX on Varnish: Has just been reorganized; progress report.

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[1] This recommendation, the object of which was to have sub-committee reports and the tentative standards to which they refer appear in the same volume, was made before the announcement by the Executive Committee that all Tentative Standards will hereafter be published collectively in the Proceedings instead of the Year-Book.—ED.

Sub-Committee X on Inspection of White-Paint Test Fence at Washington, D. C.: Discharged in 1916.

Sub-Committee XI on Paint Thinners Other than Turpentine: Active; report appended.

Sub-Committee XII on Turpentine: Active; progress report.

Sub-Committee XIII on Shellac: Active; report appended.

Sub-Committee XIV on Preparation of Iron and Steel Surfaces for Painting: Active; report appended.

Sub-Committee XV on Specifications for Pigments: Active; progress report.

Sub-Committee XVI on Terms Used in Reporting the Condition of Painted Surfaces: Active; progress report.

Sub-Committee XVII on Testing of Pigments for Fineness by the Use of Screens: Authorized at meeting April 26, 1916; not yet organized.

A special sub-committee has just been appointed to advise the whole committee on the practicability of plans for a systematic study of the physical problems connected with paint. It is hoped and believed that this special sub-committee will be able to suggest work on entirely new lines which will lead to important results.

This report has been submitted to letter ballot of the committee, which consists of 86 members; 61 ballots were cast, 25 not voting. The vote was taken on each section of the report. Following is the result of the ballot:

General Report	52	affirmative	0	negative
Report of Sub-Committee III	56	"	0	"
Report of Sub-Committee V	56	"	0	"
Report of Sub-Committee XI	57	"	1	"
Report of Sub-Committee XIII	55	"	0	"
Report of Sub-Committee XIV	53	"	0	"

Respectfully submitted on behalf of the committee,

P. H. WALKER,
Chairman.

G. W. THOMPSON,
Secretary.

EDITORIAL NOTE.

The proposed revisions of the Standard referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916. The Standard as thus revised appears in the 1916 Volume of A.S.T.M. Standards.

The proposed Tentative Standards referred to in the report were accepted for publication, and appear on pages 518–528 and 536–547.

REPORT OF SUB-COMMITTEE III ON TESTING OF PAINT VEHICLES.

The sub-committee recommends that the following changes be made this year in the Standard Specifications for Purity of Raw Chinese Wood Oil (Serial Designation: D 12-15):[1]

1. That the following sentence be inserted in the section on the "Iodine Jelly Test," after the sentence reading "The arrangement of the apparatus is shown in Fig. 1.":

> "The chloroform used to dissolve the oil and to prepare the iodine solution shall conform to the requirements of the United States Pharmacopœia and shall have a specific gravity at 25°/25° C. of not more than 1.481 and not less than 1.480. The proper density can be obtained by washing with water if the specific gravity is too low or by adding 95-per-cent ethyl alcohol if too high."

2. That the term "Tung Oil" shall be used in place of the term "Chinese Wood Oil."

TESTS ON PERILLA OIL.

The work carried out during the past year has been entirely devoted to a study of the oil derived from the perilla plant, which has probably the highest iodine number of any known drying oil obtainable in commercial quantities. The oil was pressed from a ton of perilla seed that was purchased by the Educational Bureau of the Paint Manufacturers' Association of the United States from a New York broker and importer. Portions of the seed were distributed to experimenters in various states throughout the country, to determine in what climates it could best be grown. The seed was old and did not germinate properly, so the growing tests were discontinued. The remainder of the seed was turned over to the U. S. Department of Agriculture for crushing tests.

The following information concerning the expression of the oil has been submitted by Mr. H. S. Bailey of the Bureau of Chemistry:

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[1] 1915 Year-Book, p. 423.

"In the pressing of this batch of seed I had two break-downs on our press and toward the end of the run stripped a pair of gears so that it was impossible to get satisfactory figures of yields. Mr. Burnett, has, however furnished me with the following analytical data:

Perilla seed No. 357, absolute ether extract	44.35
Perilla seed cake No. 358, absolute ether extract	14.65
Weight of seeds pressed, lb	485
Oil obtained, gallons	about 18

"There was a large amount of sediment in this oil and we had to let it stand in carboys about a week before filtering. As we did not want to expose the oil any more than necessary during filtering, I presume there was quite a considerable waste of oil left in the sediment in the bottles and on the filters."

The oil crushed from the seed was delivered to the Institute of Industrial Research and portions were then submitted to the various members of the sub-committee. The detail reports of the experimenters are appended. They indicate that perilla oil gives satisfactory results when used for the various purposes for which linseed oil is used.

Respectfully submitted on behalf of the sub-committee,

H. A. GARDNER,
Chairman.

APPENDIX.

REPORTS OF ANALYSTS ON PERILLA OIL.

REPORT OF H. A. GARDNER.

Constants of the Oil as Received.—The constants of the oil as received were as follows:

Specific gravity	0.935
Acid number	7.2
Saponification number	194.2
Iodine number	198.3

Investigation of Effect of Heat Treatment upon Constants.—Several portions of the oil were heated individually in open beakers to 300, 400 and 500° F., respectively, the oil samples being held at these temperatures for a period of ten minutes. Upon cooling, the samples were examined and their constants determined. These are as follows:

Constant.	Oil Heated to Temperature of		
	300° F.	400° F.	500° F.
Specific gravity	0.935	0.936	0.936
Acid number	7.6	6.5	6.6
Saponification Number	193.8	193.2	194.0
Iodine number	198.2	195.5	189.1

Experiments on the Drying Properties of Perilla Oil in Paints.—To determine the relative drying properties of linseed oil and perilla oil, samples of sublimed white lead, zinc oxide, and lithopone were individually ground in perilla oil and in linseed oil. The proportion of pigment to oil in each case was standard, the amounts being as follows:

Sublimed white lead	Pigment 70 per cent,	Oil 30 per cent
Zinc oxide	Pigment 50 "	Oil 50 "
Lithopone	Pigment 60 "	Oil 40 "

During grinding, it was apparent that perilla oil forms a paint of greater body than linseed oil.

Without the addition of drier or thinner of any type, these paints wer spread upon wooden surfaces and the drying times noted. They are as follows

	IN LINSEED OIL.	IN PERILLA OIL.
Sublimed white lead	17 hours	17 hours
Zinc oxide	17 "	20 "
Lithopone	17 "	20 "

All the paints in the above tests were then treated with 2 per cent of a concentrated liquid drier. They were again brushed out upon wooden surfaces and the time of drying in each case was substantially 12 hours, the perilla-oil paints showing somewhat greater hardness of film.

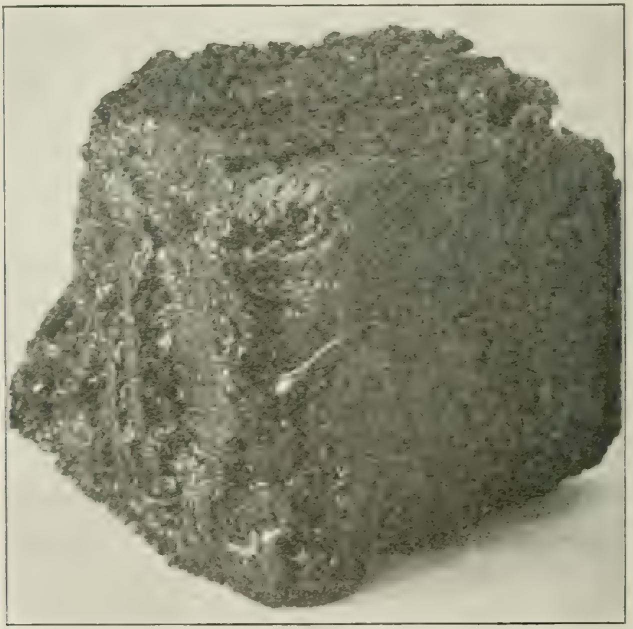

FIG. 1.—Oxidized Oil for Rolled Linoleum.

These tests indicate that although perilla oil has a higher iodine number than linseed oil, it is not necessarily a better drying oil when used in its raw state. Nevertheless, it is apparent that the addition of drier to the perilla oil rapidly accelerates its oxygen-absorbing properties, possibly to a greater extent than would be shown by a linseed oil of equal iodine value.

Exposure tests of large-size wooden panels painted with a mixture of white lead and zinc pigments ground in linseed oil and mixtures of linseed oil with varying percentages of perilla oil, have now been exposed for over four years, repainting tests having been made two years ago.[1] These tests show that perilla oil forms a very durable paint, the results obtained with many of the mixtures being equal to or possibly superior to those shown by straight linseed oil.

Experiments on the Suitability of Perilla Oil for Use in Linoleum Manufacture.—In the manufacture of linoleum, two types of oxidized oil are used.

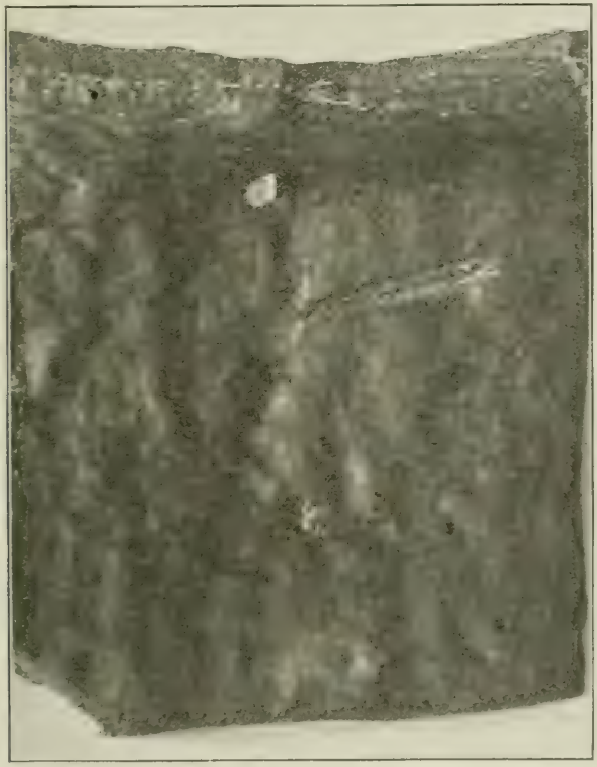

FIG. 2.—Oxidized Oil on Scrim Cloth for Inlay Linoleum.

For the production of rolled linoleum, linseed oil is raised to a temperature of 400° F., there being added during the heating, litharge and red lead as drier, in the proportion of about 1 per cent. The oil is then blown with a current of air for about two hours. This oil is subsequently transferred to so-called oxidizing kettles where it is raised to a temperature of about 600° F. At this point the oil is blown for a period of about 3 hours. It is then poured into a box and allowed to cool to a rubber-like solid which is cut up into large chunks approximately the size of hams (see Fig. 1). These are sprinkled with red lead, ochre and similar pigments and put through steam-heated rolls where the mass is rolled on a fabric backing.

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[1] H. A. Gardner, "The Practical Testing of Drying and Semi-Drying Paint Oils," ***Proceedings***. Am. Soc. Test. Mats., Vol. XI, p. 641 (1911).

For the production of inlay linoleum, linseed oil is allowed to flow over large sheets of scrim cloth hung from the ceiling of a so-called scrim house (see Fig. 2). The alternate flooding and oxidation produces at the end of several months a sheet of oxidized oil approximately $\frac{1}{2}$ in. in thickness. Upon aging, this is ground up, being very friable, and a meal of oxidized oil results. This is mixed with wood flour, color and binder and pressed into molds to form the desired pattern.

The writer has experimented with perilla oil and has found that it may be used with excellent results for the manufacture of either type of oxidized oil referred to above. The tests made were on a laboratory scale, but followed in detail the commercial practice of preparing the solidified oil produced from linseed.

Report of E. W. Boughton.

ANALYSIS OF SAMPLE.

Color	amber
Odor	sweet
Appearance	clear
Specific gravity at 15°.5/15°.5 C.	0.9350[a] 0.9351[b]
Average	0.9351
Acid number	8.6 8.6
Average	8.6
Saponification number	192.9 193.9
Average	193.4
Refractive index at 25° C.	1.4821
Iodine number (Hanus)	200.2 198.8
Average	199.5

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[a] Determined with a plummet at room temperature (19° C.); result calculated to 15°.5/15°.5 C., assuming a change in density of 0.00069 per degree Centigrade.

[b] Determined with a pyknometer at 15°.5/15°.5 C.

Analysis of Sample.—*Continued.*

Ash, per cent	0.01 0.01
Average	0.01
Unsaponifiable matter, per cent[1]	0.81 0.75
Average	0.78
Hexabromides, per cent[2]	61.71 60.98 60.54
Aver	61.08
Color of hexabromides	light pink

DRYING TESTS.

Films of perilla oil and of raw linseed oil, weighing 0.2 g., were spread on a ground-glass surface 10 by 10 cm., and the gain in weight noted. The results are as follows:

Oil.	Maximum Gain in Weight, per cent.	Time Required for Maximum Gain in Weight, days.
Perilla oil	17.5	3
North American raw linseed oil No. 4	15.8	5
South American raw linseed oil No. 36	14.5	5

Boiled perilla oil was prepared by heating 10 cc. of the raw oil with 0.15 g. of PbO and 0.05 g. of MnO_2 for 10 minutes, and then adding 40 cc. of the raw oil. The mixture was then heated at 200° C. for 15 minutes. This boiled oil showed on analysis:

Specific gravity at 15°.5/15°.5 C	0.9399
Iodine number (Hanus)	195.1
Ash, per cent	0.26
Lead, per cent	0.19
Manganese, per cent	0.017

When flowed on glass and the plate set at an angle of 45 deg., the film dried to touch in less than 16 hours. When dried under the same conditions as were the raw oils, that is, 0.2 g. of oil spread on a ground-glass surface 10 by 10 cm., this boiled perilla oil showed a maximum gain in weight of 14.8

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[1] Determined by the Böhmer method, using alcoholic NaOH; 13 g. of oil were used and two saponifications were made in each determination.

[2] Determined by Eibner's method.

per cent in 5 hours, no weighing being made before 5 hours had elapsed. The films of raw and boiled perilla oil did not show any tendency to streak or coagulate, as is mentioned by Lewkowitsch.[1]

REPORT OF NEMZEK AND REDDY.

Constants of the Oil as Received.—The constants of the oil as received were as follows:

Specific gravity	0.9296
Acid number	8.4
Saponification number	191.7
Iodine number	196.1

Small batches of paint and varnish were made up with perilla oil in place of the linseed oil. These paints and varnishes have been applied to panels and durability exposure tests are being made upon them.

REPORT OF THOMPSON AND MILLS.

Constants of the Oil as Received.—The constants of the oil as received were as follows:

Specific gravity at 15°.5/15°.5 C	0.9304 0.9298 0.9298
Average	0.9300
Acid number	7.71 7.59
Average	7.65
Saponification number	191.9
Iodine number of oil (Hanus)	197.5 197.8
Average	197.7
Iodine number of fatty acids (Hanus)	203.8 204.2 203.8
Average	203.9

---

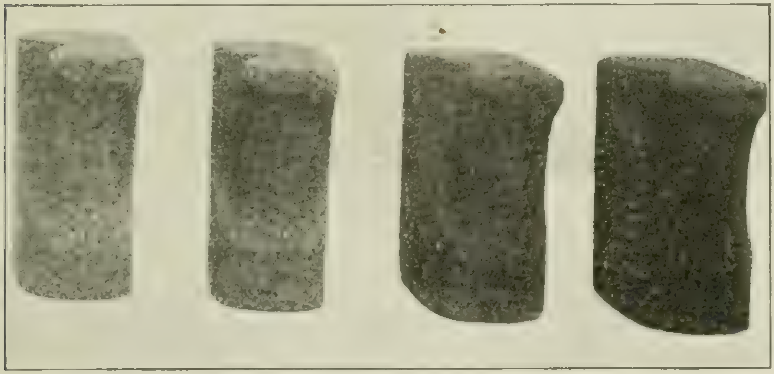
[1] "Chemical Technology and Analysis of Oils, Fats and Waxes," 5th edition, Vol. II, p. 43

Hexabromides of fatty acids, per cent	64.35 63.70
Average	64.03
Unsaponifiable matter soluble in ether, per cent	0.64
Refractive index at 25° C	1.4809
Ash in oil, per cent	0.028

Time did not permit a more extended investigation except in the case of the determination of the hexabromides. The Eibner method as modified by Mr. Thompson gives very good results on this oil, and duplicate determinations agree well within 1 per cent. In view of the fact that the yield of hexabromides is higher for perilla oil than for any other oil we have tested, we believe this to be one of the most valuable tests.

REPORT OF C. T. BRAGG.

Experiments made by C. T. Bragg on the usefulness of perilla oil in place of linseed oil for the manufacture of high-grade cores in foundry work, indicate that the perilla oil is excellent for the purpose. Illustrations of such cores made from perilla and linseed oils are given in Fig. 3.



(*a*) From Linseed Oil. (*b*) From Perilla Oil.

FIG. 3.—High-Grade Foundry Cores.

REPORT OF R. W. LINDSAY.

Specific gravity at 25°/25° C	0.925
Refractive index at 25° C	1.4806
Saponification number	192.1
Acid number	7.76
Iodine number	196.9
Unsaponifiable matter, per cent	1.56

In addition to the determination of the above, tests were made to determine the value of perilla oil in varnish making. We find that in the heat test, perilla oil bodied up quicker than does linseed oil and having been thus bodied up, has better drying properties than linseed oil. At present nothing can be said as to the relative durability of perilla oil and linseed oil.

From these rather preliminary tests, it looks very much as though perilla oil would make an excellent varnish oil.

REPORT OF SUB-COMMITTEE V ON LINSEED OIL.

South American flaxseed is being imported in large amount for the manufacture of linseed oil. In order that data showing the constants of such oil might be available, the sub-committee secured three samples each of raw and boiled linseed oil from the 1914–1915 crop of Argentine seed.

The history of these samples is as follows:

No. 36, raw linseed oil, from South American seed from Argentine, La Plata, 1914–1915 crop. Sample taken at the Edgewater Plant of the Midland Linseed Products Co., Edgewater, N. J., by Mr. Higgins of the New York Food and Drug Laboratory. Mr. Lowe, Superintendent, stated that the oil was produced by hydraulic pressure followed by one filtration. Made July 15, 1915. Sample taken and shipped July 23, 1915. Bottled December 1, 1916, by G. H. Pickard.

No. 37, raw linseed oil, from South American seed from La Plata 1914–1915 crop. Sample taken at the Atlantic Works of the National Lead Co., Brooklyn, N. Y , by Mr. Higgins of the New York Food and Drug Laboratory. Mr. W. J. Muesch, General Foreman of the Linseed Oil Department, stated that the oil was produced by hydraulic pressure followed by filtration hot and later cold. Made June 26, 1915. Sample taken and shipped July 19, 1915. Bottled December 1, 1915, by G. H. Pickard.

No. 38, raw linseed oil, from South American seed from the Argentine 1914–1915 crop. Sample taken at the Dean Works of the American Linseed Co., Staten Island, N. Y., by Mr. Higgins of the New York Food and Drug Laboratory. Mr. Robert Brown, Manager, stated that the oil was produced by hydraulic pressure followed by filtration hot and later cold. Made about July 6, 1915. Sample taken and shipped July 21, 1915. Bottled December 1, 1915, by G. H. Pickard.

No. 39, boiled linseed oil, from South American seed from Argentine, La Plata, 1914–1915 crop. Sample taken at the Edgewater Plant of the Midland Linseed Products Co., Edgewater, N. J., by Mr. Higgins of the New York Food and Drug Laboratory. Mr. Lowe, Superintendent, stated that the oil was prepared from raw oil, by addition of a linoleate drier. Sample taken and shipped July 23, 1915. Bottled December 1, 1915, by G. H. Pickard.

No. 40, boiled linseed oil, from South American seed from La Plata 1914–1915 crop. Sample taken at Atlantic Works of the National Lead Co., by Mr. Higgins of the New York Food and Drug Laboratory. Mr. Muesch, General Foreman, stated that it was prepared from raw oil by the addition of a linoleate drier. Wood-fire boiled; old-fashioned kettle-boiled linseed oil.

Sample taken and shipped July 19, 1915. Bottled December 1, 1915, by G. H. Pickard.

No. 41, boiled linseed oil, from South American seed from Argentine 1914–1915 crop. Sample taken at the Dean Works of the American Linseed Co., by Mr. Higgins of the New York Food and Drug Laboratory. Mr. Robert Brown, Manager, stated that the oil was prepared from raw oil, by the addition of resinate drier. Sample taken and shipped July 22, 1915. Bottled December 1, 1915, by G. H. Pickard.

These samples were sent to the several analysts reporting with the request that the specification constants, together with the percentage of insoluble hexabromides, be determined on each sample. The analysts whose results are given herewith are:

No. 1, G. W. Thompson, Chief Chemist, National Lead Co., 129 York Street, Brooklyn, N. Y. Work done by C. B. Mills.

No. 2, E. W. Boughton, Associate Chemist, Bureau of Standards, Washington, D. C.

No. 3, M. Y. Seaton, Technical Director, The Arco Co., Cleveland, Ohio. Work done by J. Alonzo.

No. 4, L. P. Nemzek, Chief Chemist, John Lucas and Co., Gibbsboro, N. J. Work done by H. A. Reddy.

Table I gives the results of each operator on the samples described; Table II the average of the results on all South American raw oils collected by the sub-committee, and Table III the average of the results on all South American boiled oils collected by the sub-committee.

These samples were sent out in the hope that specifications could be based on the results. Referring to Table II a wide difference is noted between the iodine numbers of sample No. 16 from the 1910-1911 crop, sample No. 23 from the 1911–1912 crop, and those samples from the 1914–1915 crop. The specific gravities also of samples Nos. 16 and 23 are lower than the others.

In view of this divergence it seems best to defer the drawing up of specifications covering raw and boiled linseed oil from South American seed until the sub-committee shall have had time to acquire more data on oil from this source.

The results of the determination of the insoluble hexabromides are disappointing in that three analysts failed of satisfactory agreement. It must be inferred that the method of determination possesses difficulties which at present preclude

TABLE I.—CONSTANTS OF OILS.

Analyst No.	Specific Gravity at 15°.5/15°.5 C.	Iodine Number.	Saponification Number.	Acid Number.	Insoluble Hexabromides, per cent.	Unsaponifiable Matter, per cent	Refractive Index at 25° C.	Ash, per cent.	Lead, per cent.	Manganese, per cent.	Calcium, per cent.
RAW OIL NO. 36.											
1	0.9328	178.4	191.7	5.30	53.29	1.09	1.4792	0.101	....	.....	.....
2	0.9329	180.2	191.2	5.86	49.41	1.20	1.4795	0.090	....	.....	.....
3	0.9329	180.8	194.9	5.24	47.40	1.01	1.4802	0.091	....	.....	.....
4	0.9330	177.3	191.8	5.50	.....	....	......	.....	....	.....	.....
Aver..	0.9329	179.2	192.4	5.48	50.03	1.15	1.4796	0.094			
RAW OIL NO. 37.											
1	0.9331	179.2	191.4	6.05	53.47	1.08	1.4792	0.127	....	.....	.....
2	0.9334	180.3	191.3	6.68	48.05	1.05	1.4793	0.123	....	.....	.....
3	0.9334	178.6	191.2	6.02	44.90	0.89	1.4801	0.133	....	.....	.....
4	0.9335	177.9	191.9	6.60	.....	....	......	.....	....	.....	.....
Aver..	0.9333	179.0	191.4	6.34	48.80	1.00	1.4795	0.128			
RAW OIL NO. 38.											
1	0.9332	179.7	191.4	3.79	53.47	1.18	1.4793	0.102	....	.....	.....
2	0.9334	181.3	191.6	4.01	50.05	1.12	1.4795	0.100	....	.....	.....
3	0.9334	181.5	190.9	4.04	45.40	0.85	1.4802	0.109	....	.....	.....
4	0.9337	178.7	188.3	3.80	.....	....	......	.....	....	.....	.....
Aver..	0.9334	180.3	190.5	3.91	49.64	1.05	1.4796	0.104			
BOILED (LINOLEATE) OIL NO. 39.											
1	0.9362	178.7	191.8	6.54	51.01	0.99	1.4801	0.223	....	.....	.....
2	0.9366	179.7	190.4	7.10	.....	1.10	1.4803	0.270	0.13	0.034	0.007
3	0.9366	180.0	188.1	6.78	44.90	0.92	1.4815	0.289	0.16	0.044	0.012
4	0.9362	173.6[a]	189.3	6.60	.....	....	......	.....	....	.....	.....
Aver..	0.9364	179.4	189.9	6.75	47.95	1.00	1.4806	0.260	0.14	0.039	0.009
BOILED (LINOLEATE) OIL NO. 40.											
1	0.9382	175.3	191.9	9.27	47.58	0.95	1.4802	0.423	....	.....	.....
2	0.9381	176.8	188.1	10.24	.....	1.22	1.4806	0.380	0.20	0.049	0.016
3	0.9382	173.8	190.3	9.67	39.80	1.07	1.4815	0.405	0.20	0.064	0.016
4	0.9383	174.4	188.6	9.70	.....	....	......	.....	....	.....	.....
Aver..	0.9382	175.0	189.7	9.72	43.69	1.08	1.4808	0.403	0.20	0.056	0.016
BOILED (RESINATE) OIL NO. 41.											
1	0.9395	180.4	189.9	8.16	50.55	1.19	1.4814	0.342	....	.....	.....
2	0.9394	181.7	187.9	9.00	.....	1.16	1.4816	0.330	0.13	0.049	0.007
3	0.9399	180.5	188.7	8.02	45.20	1.31	1.4826	0.342	0.16	0.057	0.016
4	0.9399	171.6[a]	188.0	8.60	.....	....	......	.....	....	.....	.....
Aver..	0.9397	180.8	188.6	8.44	47.88	1.22	1.4819	0.338	0.14	0.053	0.011

[a] Omitted from average.

the addition to our specifications of limits for the percentage of insoluble hexabromides.

The results, however, indicate that the amount of insoluble hexabromides in raw oil from South American seed is about the same as that in oil from North American seed, which fact renders the solution of the problems in connection with this determination all the more desirable, for, once established, this determination would prevent sophistication of high-constant oils with vegetable oils. The sub-committee urges all interested to spend time investigating this most interesting problem.

TABLE II.—CONSTANTS OF SOUTH AMERICAN RAW LINSEED OILS.

Sample No.	Specific Gravity at 15°.5/15°.5 C.	Iodine Number.	Saponification Number.	Acid Number	Insoluble Hexabromides, per cent.	Unsaponifiable Matter, per cent.	Refractive Index at 25° C.	Ash, per cent.	Lead, per cent.	Manganese, per cent.	Calcium, per cent.
16	0.9326	170.8	191.4	1.47	.....	....	1.4785	.....	....	.....	.....
23	0.9315	172.3	190.5	3.54	.....	....	1.4784	.....	....	.....	.....
36	0.9329	179.2	192.4	5.48	50.03	1.15	1.4796	0.094	....	.....	.....
37	0.9333	179.0	191.4	6.34	48.80	1.00	1.4795	0.128	....	.....	.....
38	0.9334	180.3	190.5	3.91	49.64	1.05	1.4796	0.104	....	.....	.....

TABLE III.—CONSTANTS OF SOUTH AMERICAN BOILED LINSEED OILS.

Sample No.	Specific Gravity at 15°.5/15°.5 C	Iodine Number.	Saponification Number.	Acid Number.	Insoluble Hexabromides, per cent.	Unsaponifiable Matter, per cent.	Refractive Index at 25° C.	Ash, per cent.	Lead, per cent.	Manganese, per cent.	Calcium, per cent.
39	0.9364	179.4	189.9	6.75	47.95	1.06	1.4806	0.260	0.14	0.039	0.009
40	0.9382	175.0	189.7	9.72	43.69	1.08	1.4808	0.403	0.20	0.056	0.016
41	0.9397	180.8	188.6	8.44	47.88	1.22	1.4819	0.338	0.14	0.053	0.011

The remarks of the analysts with reference to their results are appended to the report. We call especial attention to the report of E. W. Boughton, which contains interesting matter not tabulated.

Respectfully submitted on behalf of the sub-committee,

GLENN H. PICKARD,
Chairman.

APPENDIX.

COMMENTS OF ANALYSTS.

Analyst No. 1.—G. W. Thompson.

No comments.

Analyst No. 2.—E. W. Boughton.

TESTS OF RAW LINSEED OIL.

All oils were normal (i. e., amber) in color, of normal odor, and clear in appearance.

The specific gravity reported for each oil is an average of two values, determined (1) with a plummet at room temperature (24–26° C.), results calculated to 15°.5/15°.5 C., assuming a change in density of 0.00069 per degree Centigrade; and (2) with a pyknometer at 15°.5/15°.5 C.

Unsaponifiable matter was determined by the Boemer method, using alcholic NaOH and 20 g. of oil. Two saponifications were made in each determination.

Determination of Hexabromides.—The results reported were selected as being the best, judging by the appearance of the hexabromides and rate of filtration. All the results obtained are reported below with results obtained on oils Nos. 1, 2, 3, and 4.

Oil No.	1	2	3	4	36	37	38
Hexabromides, per cent	51.94	49.12	51.30	49.76	49.00	47.86	49.60
	52.02	49.52	51.60	50.40	49.33	47.97	50.29
	.....	50.07	51.64	50.60	49.38	48.00	50.50
	.....	50.32	.....	50.92	49.44	48.13	50.74
	.....	50.63	.....	51.08	49.69	48.50	.....
	.....	50.70	.....	51.33	50.22	.....	.....
	.....	50.84	.....	51.59	50.26	.....	.....
	.....	51.07	.....	.....	.....	.....	.....
	.....	51.54	.....	.....	.....	.....	.....
Average	51.98	50.42	51.51	50.81	49.62	48.09	50.28
Determinations rejected because hexabromides were yellow	.....	52.26	.....	48.46	48.74	47.19	48.84
	.....	52.58	.....	49.47	50.44	50.01	51.52
	.....	52.69	.....	52.99	51.54	50.56	.....
	.....	56.60	.....	53.25	.....	51.19	.....
	.....	57.00	.....	52.69	.....	51.86	.....

Drying Tests.—Films of oil weighing 0.2 g. were spread on a ground glass surface 10 by 10 cm., and the gain in weight noted. South American oils Nos. 36-38 showed results that were similar to those obtained with North American oil No. 4.

Oil No.	Maximum Gain in Weight, per cent.	Time Required for Maximum Gain in Weight, days.
36	14.5	5
37	14.1	5
38	14.6	5
4	15.8	5

TESTS OF BOILED LINSEED OIL.

All oils were dark in color, of normal odor, and turbid in appearance. The specific gravity and unsaponifiable matter were determined in same manner as for raw oils.

Determination of Metals in Ash.—Two methods were used on each sample and the average value reported.

Method No. 1 is as follows: The ash was dissolved in HCl, Pb and Mn were precipitated with $(NH_4)_2S$ and Ca determined in the filtrate by precipitation as oxalate and ignition to CaO. The PbS and MnS were dissolved in HCl, and Pb determined by precipitation and weighing as $PbSO_4$. Mn was determined in the filtrate from the $PbSO_4$ by the bismuthate method.

Method No. 2 is as follows: The ash was dissolved in HNO_3 and H_2O_2 and the Pb determined electrolytically by deposition and weighing as PbO_2. $(NH_4)_2S$ was added to the electrolyte after removal of Pb, the precipitate was filtered off, and Ca determined in the filtrate by precipitation as oxalate and ignition to CaO. Mn was determined in an aliquot of the original solution of the ash by the bismuthate method.

The results by the two methods are as follows:

Oil No.	Lead, per cent.			Manganese, per cent.			Calcium, per cent.		
	Method No. 1.	Method No. 2.	Average.	Method No. 1.	Method No. 2.	Average.	Method No. 1.	Method No. 2.	Average.
39	0.12	0.14	0.13	0.033	0.034	0.034	0.008	0.005	0.007
40	0.20	0.20	0.20	0.047	0.050	0.049	0.013	0.019	0.016
41	0.12	0.13	0.13	0.047	0.051	0.049	0.007	0.006	0.007

Drying Tests.—When oils were flowed on a ground-glass plate and the plate set at an angle of 45° all 3 samples dried to touch in less than 16 hours.

Films of oil weighing 0.2 g. were spread on a ground-glass surface 10 by 10 cm. and the gain in weight noted. The results follow:

Oil No.	Maximum Gain in Weight, per cent.	Time Required for Maximum Gain in Weight.
39	14.6	Between 7 and 24 hours.
40	13.6	Between 7 and 24 hours.
41	14.0	Between 7 and 24 hours.

ANALYST NO. 3.—M. Y. SEATON.

No particular difficulty was found with determinations of hexabromides, although results of individual determinations did not check very closely. It was observed in numerous determinations that a moderate difference in the excess of bromine changed the yield of hexabromides very considerably. In this respect the method appears to be similar to the iodine-number determinations, where various investigators have shown considerable variation in iodine numbers when different amounts of iodine solution are used. It would appear that results can be checked only when the weights of samples are practically exactly identical. Determination of hexabromides was always made the same day that the preparation of the acids was finished. It was found that a slight change in constants occurred even when the acids were preserved in tightly stoppered vials. On this account, also, the determination of the iodine value of the fatty acids was not made.

Some difficulty was found in keeping the wash ether at −10°, and as the hexabromides are decidedly soluble if the temperature rises much above this point it would appear that this is a source of error which must be carefully watched. In every case the final precipitate was pure white and did not sinter.

Unsaponifiable matter was determined by extraction of the soaps dried at 100° C. with petroleum ether boiling between 40 and 60° C. which had been dried over sodium.

One only of the boiled oils (No. 41) gave a positive test for rosin. No determination of the amount present was attempted.

The standard methods were used for the determination of the constituent of the ash of the boiled oils.

ANALYST NO. 4.—L. P. NEMZEK.

No comments.

REPORT OF SUB-COMMITTEE XI ON PAINT THINNERS OTHER THAN TURPENTINE.

The sub-committee has held two general meetings during the year with average attendance of 9 in a total membership of 18.

Solvent Power.—The sub-committee reported last year that no satisfactory method of determining solvent power had been developed. During the past year no method has been found of such value as to merit investigation.

Evaporation Rate.—The methods reported last year gave such divergent results as to preclude the use of any of them as a standard test. Another test has been under the consideration of the sub-committee, namely, the comparative time of evaporation of several liquids when the same quantity of each is placed on similar pieces of white paper. It is the opinion of the sub-committee that tests of this nature would not differentiate between various liquids with sufficient accuracy to be of value. The sub-committee would welcome suggestions for any test which appears to be of value, as they find that there is a demand in various industries for a quick test for determining the general suitability of a thinner for some classes of work.

Specific Gravity.—At a meeting of the sub-committee on January 6, 1916, the following method for determining specific gravity of paint thinners other than turpentine was adopted for submission as a tentative standard:

"The specific gravity may be determined by a hydrometer, Westphal balance, or pyknometer, provided these instruments are verified. The observations shall be taken with the sample at 15°.56 C. (60° F.) and compared with water at the same temperature."

The letter ballot of the sub-committee resulted as follows: 14 in favor of adoption, none against, and 4 not voting.

Distillation.—The sub-committee has prepared a sample of liquid and distributed it to its members for a systematic investigation of the method of test described in its last year's report.[1] The results of this test are not as yet available, as complete reports have not been received. The sub-committee deems this distillation test as of the greatest value in establishing the character and suitability of paint thinners for commercial use. A careful test of the tentative method is now under way in thirteen laboratories of the sub-committee members, and when this work is completed, the sub-committee hopes to be in a position to recommend a standard distillation test.

Flash Point.—A careful study and analysis of the results of the two series of flash-point tests made in 1914 and 1915 established the fact that the commonly used open-cup testers do not give sufficiently concordant results to warrant their consideration as a standard method of test.

The sub-committee therefore deemed it advisable to devise a new form of closed cup, endeavoring to eliminate the disadvantages and combine the virtues of the several closed cups now in use. The proposed cup is of simple construction and operation and comparatively inexpensive. The results so far obtained have been most encouraging. When this investigation is completed it is the purpose of the sub-committee to present the complete results of the past three years work on this subject.

Finally, the sub-committee recommends that the tentative method for determination of specific gravity, given above, be combined with the Tentative Test for Distillation of Paint Thinners other than Turpentine (published in the 1915 Year-Book), under the title of "Tentative Tests for Paint Thinners other than Turpentine," and that the latter, which is appended hereto,[2] be published as tentative.

Respectfully submitted on behalf of the sub-committee,

CLOYD M. CHAPMAN,
Chairman.

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[1] "Tentative Test for Distillation of Paint Thinners other than Turpentine," 1915 Year-Book, p. 567.

[2] These Tentative Tests appear on pp. 518–521.—ED.

REPORT OF SUB-COMMITTEE XIII ON SHELLAC.

In its report last year, the sub-committee presented a Tentative Test for Moisture in Bleached Shellac, which was printed among the Tentative Standards in the 1915 Year-Book.[1]

In its report two years ago,[2] the sub-committee presented: (1) Method for the Determination of Resin in Shellac, and (2) Insoluble Test for Shellac.

It is recommended that these three tests be combined, as appended to this report,[3] under the title of "Tentative Tests for Shellac," and published as tentative.

Respectfully submitted on behalf of the sub-committee,

A. C. Langmuir,
Chairman.

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[1] P. 571.

[2] *Proceedings*, Am. Soc. Test Mats., Vol. XIV, Part I, p. 344 (1914).

[3] These Tentative Tests appear on pp. 522-528.—Ed.

REPORT OF SUB-COMMITTEE XIV ON PREPARATION OF IRON AND STEEL SURFACES FOR PAINTING.

The sub-committee begs to report as follows:

The preparation of a steel or iron surface for painting should be such as will secure proper adhesion of paint to that surface. It is improbable that paint ever acts chemically on these metals; and the persistence of paint on iron is primarily a matter of adhesion, which may be lessened or destroyed by (1) any unsatisfactory surface, and (2) by the entrance or intrusion of solid or fluid material between the paint film and the metal.

Recently-rolled steel or iron is covered with a mill scale of anhydrous oxide, and if painted at once, the paint never touches the metal, but is applied to the mill scale. If this mill scale ever comes off, the paint comes with it, sometimes in scales. If the metal begins to rust by access of air and moisture, the rust penetrates under the mill scale and loosens it.

In addition to mill scale and rust, other objectionable surface coatings which are frequently encountered are dirt, grease, oil, water and frost.

In considering methods for preparing these surfaces for painting it is well to take account of the methods used to secure the adhesion of substances other than paint to iron or steel. Such cases are, for example, the electrodeposition of copper or other metals; the plating of iron by molten metal; the coating of steel or iron with a vitreous enamel, which is practiced in making enameled vessels for cooking and the like; and the application of varnish enamels, such as are used on bicycles and many other metal surfaces. In all these processes it is essential that the adhesion should be perfect; that is, that the coating should wear off from the outside, not peel off from the metal; and this is what is desired with paint. In all these cases, it is universally believed to be necessary that the coating material should come in actual contact on all parts of the surface with the actual metallic surface of the iron or steel; the latter must be freed from all dirt and grease, and from all scale and rust, before the coating is applied. This is done by (1) cleaning the surface with chemically active liquid, such as sulfuric acid, (2) by the sand-blast, and (3) by other mechanical means, such as filing or polishing with an emery-belt, and the like. Unless this is done, it is found that the superimposed coating is likely to scale or flake off.

The thorough methods of cleaning by sand-blasting and pickling can be and sometimes are applied to structural and car steel for painting and for repainting, and undoubtedly are the best methods known for the purpose. They are, however, much more expensive than the ordinary method which consists in scraping, wire-brushing and wiping grease and oil spots with gasoline or benzine.

The sand-blasting method has the advantage over the pickling method in that it is more general of application, the pickling method being confined to the shop and generally to the material before assembling. It may, however, be of interest to know that good authorities maintain that iron or steel cleaned by pickling holds a coating more securely than that which is sand-blasted, and that this is owing to the rougher surface, viewed with a microscope, of the acid-etched metal.

The scraper and wire brush do not remove the firmly adhering mill scale, in consequence of which most of the structural and freight-car steel is painted over mill scale. It must be remembered that all platers and enamelers insist absolutely on the complete removal of mill scale; therefore it must not be regarded as harmless, although it certainly is less dangerous than ordinary rust.

Builders of ships for service in sea waters have frequently required the pickling or sand-blasting of the steel parts which are to be submerged, in order to remove the mill scale, and it is the common practice to do likewise for steel passenger-car bodies. The removal of mill scale at the expense of incipient rusting is also sometimes attempted by the erection of steel structures without paint and allowing them to stand exposed to the weather for several months before painting.

In addition to cleanliness of surface, freedom from dampness, severe cold and frost is considered essential to the proper adhesion of paint. This may be accomplished by painting outdoors only in warm, dry weather, or by keeping the material under cover in warm dry air during the process of cleaning and painting. Heating of surfaces is also resorted to.

While for some purposes, such as sea-going ships and passenger-car bodies, there seems to be little question as to the final economy of incurring the additional first cost of the more thorough methods of cleaning, the economy of such methods for ordinary steel structures and freight cars is not so certain.

The sub-committee has considered the subject carefully at three meetings and recommends a series of panel tests to demonstrate, if possible, the relative merits of the different methods of preparing the surfaces and the effect of extremes of atmosphere and temperature conditions during painting. A program for such a series of tests has been prepared and is appended.

The sub-committee asks for further instructions, suggesting that it be instructed to proceed with the tests.

Respectfully submitted on behalf of the sub-committee,

A. W. CARPENTER,
Chairman.

APPENDIX.

TENTATIVE SCHEDULE OF TESTS ON PREPARATION OF IRON AND STEEL SURFACES FOR PAINTING.

Tests are to be made on plates of ordinary structural steel or car steel of two general classes, namely:

A.—New steel;

B.—Steel which has been painted and become partly rusted.

A.—Tests to be Made on New Steel.

A-1, as from mill, with surface clean and free from rust and with mill scale intact; to be painted indoors in warm, dry air.

A-2, with surface in average condition of steel which has been through fabricating processes, that is, with some surface rust, oil, etc. (if no material in this condition is available, the condition should be produced by special treatment of new material by punching, smearing on of oil, grease, etc.); to be cleaned with scraper and wire brush, and oil and grease spots wiped with benzine or gasoline-soaked waste; to be painted indoors in warm, dry air.

A-3, surface as for A-2; separate plates cleaned with sand blast and painted immediately thereafter, under the following conditions:

(1) Painted indoors in warm, dry air;
(2) Painted indoors in warm, dry air after heating the plate;
(3) Painted indoors in damp atmosphere;
(4) Painted outdoors in cold, dry weather.

A-4, surface as for A-2; cleaned with sand blast and left to stand outdoors for one week, then painted indoors in warm, dry air.

A-5, surface as for A-2; cleaned by pickling process and painted immediately thereafter indoors in warm, dry air. Directions for pickling to be as specified hereinafter.

A-6, surface as for A-2; cleaned by pickling process and left to stand outdoors for one week, then painted indoors in warm, dry air.

A-7, as from mill with mill scale intact, exposed to weather until mill scale becomes disintegrated and loosened so that it can be all cleaned off with wire brush; then cleaned with wire brush; to be painted indoors in warm dry air.

B.—TESTS ON STEEL WHICH HAS BEEN PAINTED AND BECOME PARTLY RUSTED.

B-1, cleaned with wire brush only, then painted indoors in warm, dry air.

B-2, cleaned with scraper and wire brush; grease spots wiped with benzine or gasoline-soaked waste, then painted indoors in warm, dry air.

B-3, brush coated with benzine over and around edges of rust spots; benzine burned off with torch, rusted surface then wire-brushed and wiped, then painted indoors in warm, dry air.

B-4, cleaned with sand blast and painted immediately in warm, dry air.

GENERAL.

The metal plates should be not less than $\frac{3}{16}$ in. thick and of dimensions, as large as possible, up to 24 by 36 in. They should be selected from steel of the same or similar composition, and preferably cut from the same original piece. The chemical composition of the steel should either be known from mill reports or ascertained by analysis.

The number of test plates for each test shall be two. All the plates and the painting, also the exposure location for one set of plates, will be furnished by the Pennsylvania Railroad Co.

The paint to be used shall be of the class generally known as iron-oxide paint and prepared on the Pennsylvania Railroad Co. Specification No. 31A. The paint will be furnished in two shades by Mr. F. P. Cheesman, who will furnish a complete description of the composition and method of preparation. The paint shall be prepared so that it will dry to the touch in 8 hours, in daylight, in a dry, fresh atmosphere, at 70° F. Two coats shall be applied, the second coat 48 hours after the application of the first coat.

An exception to the drying property of the paint and the intervals between application of coats will be made in case of test A-3 (3)—sand-blasted surface painted indoors in damp atmosphere. In this case the tests shall be made in two parts, one a plate coated with paint to which drier has been added to produce drying to touch in 8 hours in the damp atmosphere of the test, and then second-coated at the end of 48 hours, with the same paint; the second plate to be coated with the standard paint and to remain in the damp atmosphere until hard dry, before applying the second coat of the same paint.

The paint should be applied in such thickness of coat as would be done in ordinary practice and a record kept of the amount of paint applied to each plate surface.

All plates will be exposed 48 hours after the application of the second coat, or as soon thereafter as practicable. One set of plates will be exposed at Altoona, Pa., the other at Brooklyn, N. Y., in the outside atmosphere at each place.

The specification for pickling of plates for tests A-5 and A-6 is as follows:

If the metal is dirty or has oil on it, it shall be dipped for five minutes in a hot 10-per-cent caustic-soda solution, after which it shall be rinsed in hot water; then it shall be pickled in a hot 10-per-cent sulfuric-acid solution until the rust and scale are removed. It is next to be dipped in hot water, then in a hot 10-per-cent carbonate-of-soda solution, then in hot water and finally dried.

If it is more convenient, the acid may be removed by washing the surface with water discharged upon it from a hose under a pressure of not less than 100 lb. per sq. in. This will completely remove the acid without the use of carbonate of soda or anything else. It is however necessary to have the water discharged at a very high velocity so as to remove the colloidal iron sulfate which is insoluble.

REPORT OF COMMITTEE D-3

ON

METHODS OF LABORATORY SAMPLING AND ANALYSIS OF COAL.

Committee D-3 (formerly designated Committee E-4) recommends that the Tentative Methods for Laboratory Sampling and Analysis of Coal, as printed in the 1915 Year-Book,[1] be revised by adding the following sentence after the words "10 minutes," page 609 of the 1915 Year-Book, under "Determination of Phosphorus, Method No. 1": "If the precipitate does not form promptly and subside rapidly, add enough ammonium nitrate to cause it to do so." The committee further recommends that these Tentative Methods, subject to certain minor changes in the wording of the titles of certain figures, be referred to letter ballot of the Society for adoption as standard.

This recommendation has received the unanimous approval of the joint committee from the American Chemical Society and the American Society for Testing Materials, the latter being represented on the joint committee by Committee D-3.

The committee asks to be continued, as the joint committee is expected to take up several matters, among which is the fusibility of coal ash, to be referred to it by the American Chemical Society.

This report has been submitted to letter ballot of the committee, which consists of 4 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

S. W. Parr,
Chairman.

Editorial Note.

The proposed Standard referred to in this report was approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appears in the 1916 Volume of A.S.T.M. Standards.

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[1] P. 596.

REPORT OF COMMITTEE D-4

ON

ROAD MATERIALS.

Committee D-4 begs to report as follows:

The Joint Conference Committee consisting of members of Committees C-9 and D-4 has given further consideration during the past year to the four proposed provisional tests contained in the 1914 report of the committee,[1] and reported upon last year.[2] After careful consideration of the report submitted to the committee this year by the Joint Conference Committee, Committee D-4 recommends that the following four proposed standards, which are appended to this report,[3] be referred to letter ballot of the Society for adoption. In the case of proposed standard No. 2, which has not been previously published as tentative, the committee requests that the necessary nine-tenths vote of those voting at the annual meeting be given to refer this proposed standard to letter ballot this year, as desired.

1. *Proposed Standard Test for Determination of Apparent Specific Gravity of Homogeneous Coarse Aggregates.*—A "Provisional Test for the Determination of the Apparent Specific Gravity of Rock" was presented in the 1914 report.[4] The method outlined therein has been discarded and the proposed method substituted.

2. *Proposed Standard Form of Specifications for Certain Commercial Grades of Broken Stone.*—This proposed standard is here presented to the Society for the first time, not having previously been published as tentative.

3. *Proposed Standard Method for Making a Mechanical Analysis of Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete.*—With but slight modification, this method is the same as the "Provisional Method for Making a

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 378 (1914).

[2] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 338 (1915).

[3] See Editorial Note, p. 304.—Ed.

[4] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 378 (1914).

Mechanical Analysis of Broken Stone or Broken Slag," presented in the 1914 report.[1]

4. *Proposed Standard Method for Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete.*—With but slight modification, this method is the same as the "Provisional Method for Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag," presented in the 1914 report.[2]

The Joint Conference Committee has voted to postpone action on (1) the methods for the determination of the specific gravity of sand and fine mineral aggregates, (2) the methods for the determination of voids in mineral aggregates, and (3) the definitions of aggregate, bank gravel, clay, filler, gravel, grit, loam, sand, screenings, sieve and silt, until opportunity has been given Committee C-9 to make further investigations pertaining to the methods mentioned and to consider definitions of the terms listed above.

Committee D-4 further recommends that the following five proposed standards, appended to this report,[3] be referred to letter ballot of the Society for adoption. Proposed Standards Nos. 5 to 7, inclusive, are designed to supersede present standards, as indicated. In the case of Nos. 6, 7 and 9, which have not been previously published as tentative, the committee requests that the necessary nine-tenths vote of those voting at the annual meeting be given to refer these proposed standards to letter ballot this year, as desired.

5. *Proposed Revised Standard Test for Penetration of Bituminous Materials.*—This test is designed to supersede the present Standard Test for Penetration of Bitumen (D 5–11).[4] It is based upon the test proposed last year in the report of Committee D-4 by the Sub-Committee on Penetration,[5] which was received and published as a progress report. The test now recommended for adoption was prepared by the Sub-Committee on Penetration during the past year and submitted by them in their report to the committee. This report, containing the

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIV, Part I, p. 381 (1915).

[2] *Ibid.*, p. 382.

[3] See Editorial Note, p. 304.—Ed.

[4] 1915 Year Book, p. 446.

[5] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, pp. 352–355 (1915).

results of comparative determinations which it is believed will prove of value to those interested in the test, is given in the Appendix to the report of the committee.

6. *Proposed Revised Standard Test for Loss on Heating of Oil and Asphaltic Compounds.*—This test is designed to supersede the present standard test of that title (D 6–11).[1]

7. *Proposed Revised Standard Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregate Used in Cement Concrete.*—This method is designed to supersede the present Standard Method for Sizing and Separating the Aggregate in Asphalt Paving Mixtures (D 7–11).[2]

8. *Proposed Standard Method for Distillation of Bituminous Materials Suitable for Road Treatment.*—With but slight modification, this method is the same as that tentatively suggested and published in the 1911 report.[3]

9. *Proposed Standard Method for Determination of Softening Point of Bituminous Materials Other than Tar Products.*—This method was outlined in the report presented last year by the Sub-Committee on Softening Point, in which the results of comparative tests of the ring-and-ball and the cube methods were given. The work of the sub-committee during the year warrants the recommendation of the ring-and-ball method as standard.

The results of the letter ballot of the committee on the above nine recommendations is as follows:

PROPOSED STANDARD.	Affirmative.	Negative.	Not Voting.
1. Apparent Specific Gravity of Homogeneous Coarse Aggregates	21	6	10
2. Form of Specifications for Certain Commercial Grades of Broken Stone	24	2	11
3. Mechanical Analysis of Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete	24	3	10
4. Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, Except for Aggregates Used in Cement Concrete	23	4	10
5. Penetration of Bituminous Materials	23	1	13
6. Loss on Heating of Oil and Asphaltic Compounds	23	1	13
7. Mechanical Analysis of Sand or Other Fine Highway Material, Except for Fine Aggregate Used in Cement Concrete	25	2	10
8. Distillation of Bituminous Materials Suitable for Road Treatment	20	1	16
9. Softening Point of Bituminous Materials Other than Tar Products	23	1	13

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[1] 1915 Year-Book, p. 447.

[2] *Ibid.*, p. 448.

[3] *Proceedings*, Am. Soc. Test. Mats., Vol. XI, pp. 241-244 (1911).

In addition, Committee D-4 recommends that the following definitions of terms applicable to materials relating to roads and pavements be published as tentative for one year and then referred to letter ballot of the Society for adoption as standard and insertion in the present Standard Definitions of Terms Applicable to Materials Relating to Roads and Pavements (D 8–15).[1] The result of the letter ballot of the committee on these recommendations is given under the respective definitions.

Clinker.—Generally a fused or partly fused by-product of the combustion of coal, but also including lava and Portland-cement clinker, and partly vitrified slag and brick.

Affirmative, 24; negative, 1; not voting, 12.

Mesh.—The square opening of a sieve.

Affirmative, 26; negative, 1; not voting, 10.

Slag.—Fused or partly fused compounds of silica in combination with lime or other bases, resulting in secondary products from the reduction of metallic ores.

Affirmative, 25; negative, 1; not voting, 11.

Petroleum.—Liquid bitumen occurring as such in nature.

Affirmative, 25; negative, 0; not voting, 12.

Topped Petroleum.—Petroleum deprived of its more volatile constituents.

Affirmative, 21; negative, 2; not voting, 14.

Rock Asphalt.—Sandstone or limestone naturally impregnated with asphalt.

Affirmative, 24; negative, 1; not voting, 12.

Bituminous Emulsion.—A liquid mixture in which minute globules of bitumen are held in suspension in water or a watery solution.

Affirmative, 23; negative, 1; not voting, 13.

Viscosity.—The measure of the resistance to flow of a bituminous material, usually stated as the time of flow of a given amount of the material through a given orifice.

Affirmative, 25; negative, 1; not voting, 11.

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[1] 1915 Year-Book, p. 462.

Penetration.—The consistency of a bituminous material expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time and temperature. Where the conditions of test are not specifically mentioned, the load, time and temperature are understood to be 100 g., 5 seconds, and 25° C. (77° F.), respectively, and the units of penetration to indicate hundredths of a centimeter.

Affirmative, 25; negative, 0; not voting, 12.

This report has been submitted to letter ballot of the committee, which consists of 37 members, of whom 22 have voted affirmatively, none negatively, and 15 have refrained from voting.

Respectfully submitted on behalf of the committee,

L. W. PAGE,
Chairman.

PRÉVOST HUBBARD,
Secretary.

EDITORIAL NOTE.

The following proposed Standards referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appear in the 1916 Volume of A.S.T.M. Standards:

Test for Penetration of Bituminous Materials;
Test for Loss on Heating of Oil and Asphaltic Compounds;
Method for Making a Mechanical Analysis of Sand or Other Fine Highway Material, except for Fine Aggregate Used in Cement Concrete;
Method for Making a Mechanical Analysis of Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete;
Method for Making a Mechanical Analysis of Mixtures of Sand or Other Fine Material with Broken Stone or Broken Slag, except for Aggregates Used in Cement Concrete;
Method for Distillation of Bituminous Materials Suitable for Road Treatment.

The following proposed Standards referred to in the report were not approved as standard, but were accepted for publication as tentative, and appear on the pages indicated below:

Test for Determination of Apparent Specific Gravity of Homogeneous Coarse Aggregates, pages 529–530;
Form of Specifications for Certain Commercial Grades of Broken Stone, page 548;
Method for Determination of Softening Point of Bituminous Materials Other than Tar Products, pages 549–550.

The tentative definitions in the report were accepted for publication among the Tentative Revisions of Standards, and appear on pages 594–595.

The action taken on the report is given in detail on pages 21–23.

For Discussion on the report, see page 316.

APPENDIX.

REPORT OF SUB-COMMITTEE ON PENETRATION OF BITUMINOUS MATERIALS.

The following report is submitted on behalf of the Sub-Committee on Penetration of Bituminous Materials, covering its work during the past year.

At the last annual meeting, this sub-committee presented a report including as its chief feature a Proposed Test for Penetration of Bituminous Materials.[1] At the subsequent meeting of Committee D-4 this report was accepted simply as one of progress and the proposed test was referred back to the sub-committee for the following reasons:

1. That the method provided for the test at only one temperature, 25° C., designated as the "normal penetration." It was considered by the committee that the customary hot and cold penetrations should have also been provided for.

2. That no actual data were submitted relative to the so-called ice-water method of cooling the samples. This practice was considered by some of the committee members as deserving investigation.

While the members of the Sub-Committee on Penetration felt that both features were amply covered in last year's work, they have nevertheless given another year's efforts to the subject, with a view of meeting the wishes of the committee. Two meetings, with practically full attendance, have accordingly been held, and a large amount of correspondence has been conducted.

At the meeting of September 13, 1915, it was decided to conduct some collaborative tests using the proposed method in comparison with an "ice-water" procedure for cooling the specimens. Bermudez and high-paraffin Mexican asphalts, at both paving-cement and road-binder consistencies, were selected as types of materials for this purpose.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 352 (1915).

In line with our study of the needle question, it was also decided to compare with the usual needle a special form devised in the laboratory of the U. S. Office of Public Roads and Rural Engineering by Messrs. Reeve and Pritchard.

Eight sets of samples and six special-type thermometers, supplied for the work by the C. J. Tagliabue Manufacturing Co., were distributed among eight laboratories and accompanying these were the regular Robert's needles furnished by Mr. Smith and the special needles supplied by Mr. Reeve. The following letter of instruction was also sent to the laboratories:

TO THE MEMBERS OF THE SUB-COMMITTEE ON PENETRATION.

Dear Sirs:

Within a few days, you will receive four samples of asphalt on which are to be made the collaborative penetration tests as agreed upon at our meeting in New York City on September 13.

Two of these samples will be Bermudez products sent out by Mr. J. S. Miller and the other two, Mexican products furnished by the writer. Both sets will consist of a "binder" or soft sample, and a harder material, approximating that of asphalt paving consistency.

On these samples kindly determine, as promptly as possible after receipt by you, their penetration by the following methods:

1. *Ice-Water Method.*—Melt the samples at as low a temperature as possible, and after stirring to insure uniformity, pour into a 3-oz. Gill style, flat-bottom, deep-pattern, seamless, tin ointment box (same as Proposed Method).

Place in ice-water maintained at 41° F. until "set," and then immerse completely in the ice water and allow to remain for a period of ½ hour.

At the end of the immersion period, transfer to a constant-temperature water bath maintained at 25° C. and allowed to remain ¾ hour, and take penetration by the use of the usual type needle. Temperature bath and details of manipulation, except as above modified, shall conform to those laid down under "Recommended Procedure."

Make at least three separate tests on each sample and enter results in proper spaces of the enclosed blank report.

2. *Proposed Method; Usual Needle.*—Pour another set of all four samples, preferably at the same time as those for the ice-water method are prepared, and proceed strictly according to our "Proposed Method" as described in the enclosed authorized reprint, beginning on page 352.

Make at least three separate tests on each sample and enter results in proper spaces of the enclosed form, retaining samples for the following method:

3. *Proposed Method; Special Needle.*—On each of the samples used in the above Proposed Method make at least three more penetration tests, using this time, the special type of needle sent out recently by Mr. Reeve.

Enter results in proper spaces of the enclosed report form.

Upon the conclusion of your tests, date and sign the report and mail to the chairman, who will in turn send copies of the tabulated data to all the members, so that we shall be prepared to discuss same at our next meeting.

I am also sending for use in connection with these experiments one thermometer from a set of six which were loaned especially for the purpose by the C. J. Tagliabue Manufacturing Co. All of the instruments indicated 77° F. when tested in the writer's laboratory in the customary bath maintained at that temperature and will, therefore, assure uniformity in this feature of the collaborative tests. They may be purchased by the individual members at a cost of $1.67 each or can be returned to the chairman at the close of the work.

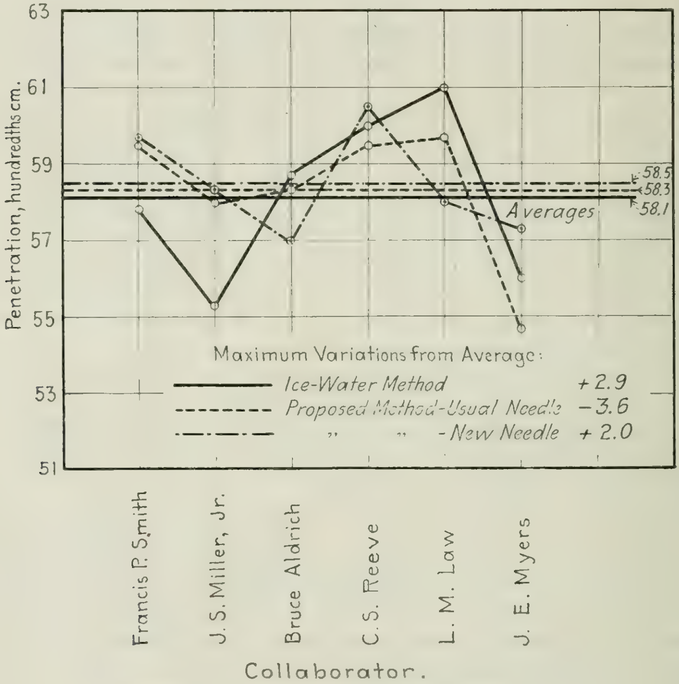

FIG. 1.—Bermudez Asphalt Cement.

Kindly acknowledge receipt of samples and this circular letter.

Yours very truly,

LEROY M. LAW,
Chairman.

The results of these tests were tabulated at the last meeting of the sub-committee held March 22, 1916.

One of the thermometers was reported to be in error to the extent of 5° F.,—an unfortunate feature which, thus far, the sub-committee has been unable to check up,—so the reports of two laboratories using this same instrument were withdrawn. This left six collaborative reports on the four materials sent out,

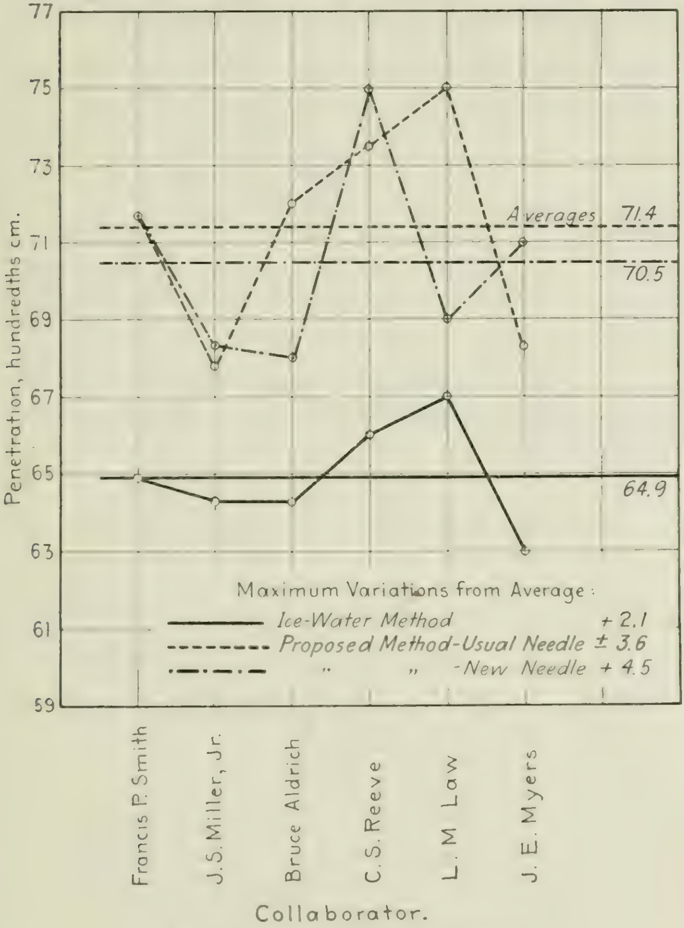

FIG. 2.—Mexican Asphalt Cement.

and through the courtesy of Mr. Miller of this sub-committee copies of the charts prepared at our last meeting are shown in Figs. 1, 2, 3 and 4.

These charts need little explanation and are corroborative of the experience of all the members of the sub-committee on work extending over a number of years. They show in most instances low results by the ice-water method, especially with the Mexican asphalt binder (Fig. 4), and there is also in general a greater variation from the average by this method. When it is considered that the six collaborators had carefully rehearsed

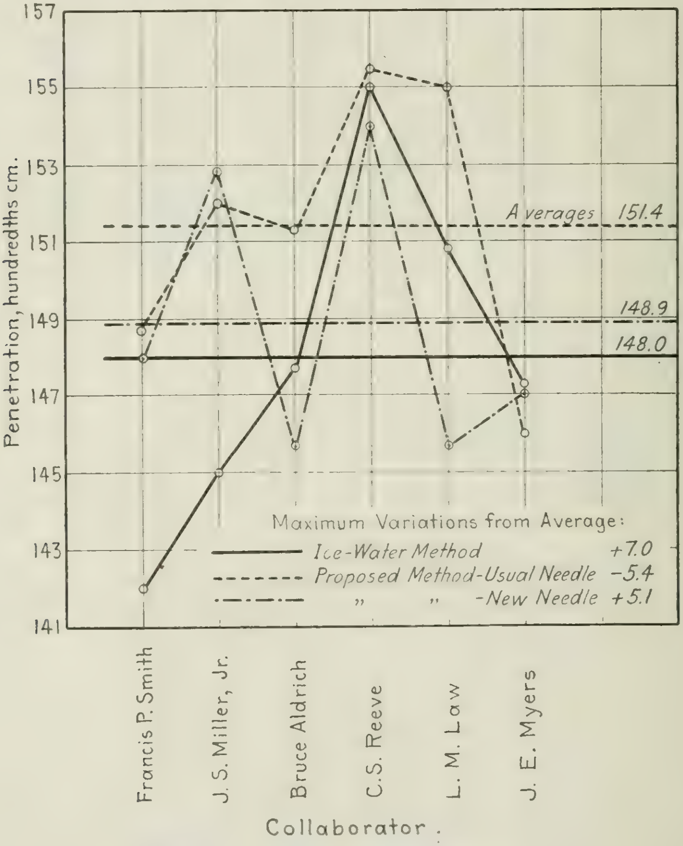

FIG. 3.—Bermudez Asphalt Binder.

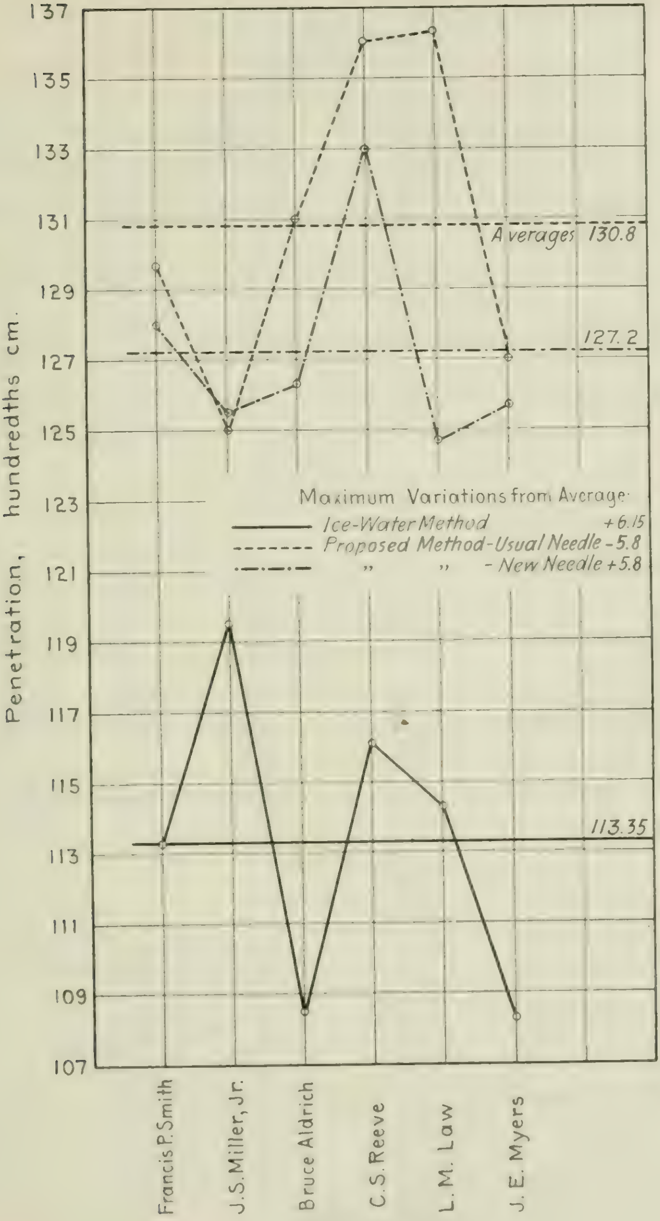

FIG. 4.—Mexican Asphalt Binder.

TABLE I.—COLLABORATIVE TESTS ON PENETRATION OF BITUMINOUS MATERIALS.

J. E. MYERS.

Kind of Asphalt.	Ice-Water Method, Usual Needle.		Proposed Method.			
			Usual Needle.		Special Needle.	
Bermudez Asphalt Cement	56 55 57	56	55 55 54	54.7	57 57 58	57.3
Mexican Asphalt Cement	61 63 65	63	68 68 69	68.3	71 71 71	71
Bermudez Asphalt Binder	149 146 147	147.3	148 146 144	146	147 146 148	147
Mexican Asphalt Binder	110 107 108	108.3	128 125 128	127	126 123 128	125.7

LEROY M. LAW.

Kind of Asphalt.	Ice-Water Method, Usual Needle.		Proposed Method.			
			Usual Needle.		Special Needle.	
Bermudez Asphalt Cement	.. 61 61 61	61	60 60 59 60	59.7	.. 58 58 58	58
Mexican Asphalt Cement	67 67 67	67	78 76 76	76.7	69 69 69	69
Bermudez Asphalt Binder	150 153 150 150	150.7	156 154 156 154	155	145 146 146 ...	145.7
Mexican Asphalt Binder	113 114 116 114	114.2	136 136 137 ...	136.3	125 124 125 ...	124.7

C. S. REEVE.

Kind of Asphalt.	Ice-Water Method, Usual Needle.		Proposed Method.			
			Usual Needle.		Special Needle.	
Bermudez Asphalt Cement	60 60.5 60.5	60	59 60 59.5	59.5	60.5 60 61	60.5
Mexican Asphalt Cement	66 65 66.5	66	73.5 73.5 73.5	73.5	75.5 75 74.5	75
Bermudez Asphalt Binder	156 153.5 155 ...	155	156.5 153.5 156.5 ...	155.5	156 152.5 154 154.5	154
Mexican Asphalt Binder	115 116 116	116	136.5 136 136.5	136	132 133 134.5	133

TABLE I.—COLLABORATIVE TESTS ON PENETRATION OF BITUMINOUS MATERIALS (*Continued*).

BRUCE ALDRICH.

Kind of Asphalt	Ice-Water Method, Usual Needle.		Proposed Method.			
			Usual Needle.		Special Needle.	
Bermudez Asphalt Cement	58 59 59	58.7	59 58 58	58.7	57 57 57	57
Mexican Asphalt Cement	65 64 64	64.3	72 72 72	72	68 68 68	68
Bermudez Asphalt Binder	148 148 147	147.7	152 152 150	151.3	147 145 145	145.7
Mexican Asphalt Binder	108 109 109	108.7	132 130 131	131	126 127 126	126.3

J. S. MILLER, JR.

Bermudez Asphalt Cement	55 55 56 55	55.2	57 57 59 59	58	59 58 58 58	58.2
Mexican Asphalt Cement	64 64 65 64	64.2	68 68 67 68	67.7	69 67 68 69	68.2
Bermudez Asphalt Binder	144 146 145 145	145	152 152 153 151	152	153 151 153 154	152.7
Mexican Asphalt Binder	120 121 118 119	119.5	125 126 125 124	125	126 126 125 125	125.5

FRANCIS P. SMITH.

Bermudez Asphalt Cement	58 58 57 58	57.7	61 59 59 59	59.5	60 59 60 ..	59.7
Mexican Asphalt Cement	65 64.5 65 65	64.9	71 72 72 ..	71.7	71 73 71 ..	71.7
Bermudez Asphalt Binder	141 141 143 143	142	149 148 149 ...	148.7	148 148	148
Mexican Asphalt Binder	113 112 115 112	113.2	131 128 130 ...	129.7	127 130 127 ...	128

TABLE I.—COLLABORATIVE TESTS ON PENETRATION OF BITUMINOUS MATERIALS (*Continued*).

HERBERT SPENCER.

Kind of Asphalt.	Ice-Water Method, Usual Needle.	Proposed Method.		
		Usual Needle.		Special Needle.
Bermudez Asphalt Cement	..	53	54.3	..
	..	55		..
	..	55		..
Mexican Asphalt Cement	..	68	68.7	..
	..	69		..
	..	69		..
Bermudez Asphalt Binder	..	143	141.7	..
	..	143		..
	..	141		..
Mexican Asphalt Binder	..	123	123.3	..
	..	123		..
	..	124		..

the details in advance, it is most likely that such variations will be greater in general commercial work.

The results with the special needle[1] are considered sufficiently satisfactory to warrant recommendation as the official type. Its definite diameter and taper facilitate the establishment of a standard and the production of duplicates; both features deserving our attention during the coming year.

As a result of the year's work, the Sub-Committee on Penetration recommends essentially the same procedure of last year, necessary and desirable modifications covering the new needle and the penetrations at other than the normal temperature, of course being appropriately incorporated.

In regard to the latter feature, the sub-committee deems it best to adhere to previous practice of the Society, namely, temperatures of 0° C. (32° F.) and 46°.1 C. (115° F.).

The sub-committee feels that it has given full consideration to its assignment during the past two years and presents the proposed Standard Test for Penetration of Bituminous Materials appended to the report of Committee D-4, as the best it can offer as an arbitration procedure. This test, in its essentials, has gained considerable publicity through publication of our progress report last year. It is already in use by most refineries and many leading testing laboratories, and no adverse criticisms have been received by the chairman. It is, therefore, recommended that it be referred to letter ballot of the Society for adoption as standard.

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[1] Since the collaborative work by the sub-committee, this type of needle has been formally announced by Messrs. Reeve and Pritchard in the *Journal of Agricultural Research*, Vol. V, No. 24, pp. 1125-1126.

Since the compilation of this report another series of tests has been made by the operator (Mr. Spencer) reporting a defective thermometer, this time using an instrument employed by one of the other collaborators. The results obtained fully support the conclusions of the sub-committee as outlined in this report and will be found among the detail reports of the various collaborators.

Copies of the detail reports of the collaborators are shown in Table I.

Respectfully submitted on behalf of the sub-committee,

LEROY M. LAW,
Chairman.

DISCUSSION.

Mr. Herschel. MR. WINSLOW H. HERSCHEL (*by letter*).—I object to the definition of viscosity, given in the report of Committee D-4, for the following reasons:

1. Viscosity is a property possessed by all liquids and the definition for viscosity of bituminous material should not be any different than the definition for viscosity of other materials. It therefore seems to me that, if it is desirable to make any definition of viscosity at all, other committees which are interested in viscosity (Committee D-2 on Lubricants, for example) should be conferred with.

Cooperation with Committee D-2 would also be desirable in regard to test for "loss on heating," which is the same thing as the "evaporation test" which is being considered by a subcommittee of Committee D-2. It would be a great advantage if the same method could be agreed upon for loss on heating an oil used as a road material, and an oil used as a lubricant.

2. I believe the word "orifice" in the definition of viscosity is incorrect. According to Bulletin No. 314 of the U. S. Department of Agriculture, entitled "Methods for the Examination of Bituminous Road Materials," by Messrs. Prévost Hubbard and C. S. Reeve, it appears that the instrument used by the Office of Public Roads and Rural Engineering for the determination of viscosity is the Engler viscosimeter. The dimensions of the outlet tube given on page 8 of the Bulletin show that its length is about seven times its mean diameter. Hence it is a *tube*—not an *orifice*. In fact, all viscosimeters which are in general use for measuring the viscosity of any substance, when of the efflux type, are provided with tubes and not with orifices.

3. To state that a practice is "usual" comes dangerously near to an implied approval. In view of the discussion at Atlantic City a year ago, and the expressed desire on the part of several members of the Society that viscosity should be expressed in absolute units, it seems undesirable that the method of determining viscosity should be mentioned in the definition, certainly

not until some report on the subject has been made by Committee D-2 and accepted by the Society. **Mr. Herschel.**

4. Omitting the parts of the definition to which I object, there remains: "*Viscosity.*—The measure of the resistance to flow of any material." Lest my criticisms appear to be destructive rather than constructive, I suggest the following:

"*Viscosity.*—The property which prevents liquids and gases from yielding immediately and without resistance to a shearing stress, like the hypothetical perfect fluid. Viscous solids are to be considered as under-cooled liquids. They yield continuously, in contrast to plastic substances from which they should be distinguished."

5. Viscosity is *not even proportional* to time of flow. When make of instrument and time of flow are stated, we may in some cases have data from which the kinematic viscosity (that is, viscosity divided by the density) may be calculated; but we do not have the absolute viscosity, which can only be calculated if the density of the fluid is known.

MR. F. C. ROBINSON (*by letter*).—The writer, who represents the Atlantic Refining Company of Pennsylvania in the Society, begs to comment as follows on the proposed Standard Test for Penetration of Bituminous Materials as recorded in the report of Committee D-4. **Mr. Robinson.**

The hour during which the hot sample is allowed to cool in the air is largely lost time. It is better practice to partially immerse the sample in water at 77° F. until it becomes hard enough to completely immerse. This saves about 40 minutes on each test and does not change the result obtained.

The directions call for stirring the sample until it is free from air bubbles. This is not stated clearly enough and does not mean just what it says. It is probable that stirring will not hasten the expulsion of bubbles; in fact it is the impression of the writer that stirring may prevent their expulsion. It would seem better to specify that the sample should be heated gently (not more than 150° F. above the melting point and not within 100° F. of its flash point and not above 400° F.) until the bubbles have disappeared.

Referring to the proposed Standard Method for Determining

Mr. Robinson. the Softening Point of Bituminous Materials other than Tar Products:

Provision ought to be made for holding the sample for a specified time (say 10 minutes) at 5° C. before heating. Failure to do this leads to irregular results when testing certain asphalts of low melting point.

REPORT OF COMMITTEE D-5

ON

COAL.

Committee D-5 submitted at the last annual meeting of the Society a proposed method for the sampling of coal, with the recommendation that it be printed in the Year-Book for one year as tentative.

The committee has held two meetings since the last annual meeting, one in December, 1915, and the other in February, 1916, for the further consideration of its tentative report. Some parts of the tentative report have been rewritten, without change however in substance.

The committee considers that through the preparation of a standard method of sampling coal, real and substantial progress will be made towards the preparation of standard specifications for the purchase of coal. The success of any method of purchase under specifications depends on sampling. If the sampling is improperly done, the analyses are unreliable, controversies ensue, the specification method is discredited, and the development of standard specifications is retarded. By the preparation of a method of sampling, the committee believes it has paved the way for continuing its efforts which may ultimately result in the preparation of standard specifications.

Committee D-5 recommends that the Tentative Method for Sampling of Coal, published in the 1915 Year-Book among the Tentative Standards,[1] be amended as indicated below and referred as amended to letter ballot of the Society for adoption as standard:

1. *Section 1.*—Insert the following sentence:

> "If the coal is crushed as received, samples usually can be taken advantageously after the coal has passed through the crusher. Samples collected from the surface of coal in piles or bins, or in cars, ships or barges, are generally unreliable."

---

[1] P. 592.

2. *Section 2.*—Strike out the phrase in brackets:

> "2. To collect samples, a shovel or specially designed tool, or mechanical means shall be used for taking equal portions or increments [of sufficient size to include the largest pieces of coal and impurities]. For slack or small sizes of anthracite, increments as small as 5 to 10 lb. may be taken, but for run-of-mine or lump coal, increments should be at least 10 to 30 lb."

3. *Section 3.*—Insert the following sentence to precede the last sentence:

> "When coal is extremely lumpy, it is best to break a proportional amount of the lumps before taking the various increments of a sample."

4. *Section 5.*—Change to read as follows, by the insertion of the matter in italics and the omission of the matter in brackets:

> "5. After the gross sample has been collected, it shall be systematically crushed, mixed, and reduced in quantity to convenient size for transmittal to the laboratory. The sample may be crushed by hand or by any mechanical means, but under such conditions as shall prevent loss or the accidental admixture of foreign matter. [The pieces of coal and impurities shall be crushed to sizes not greater in any dimension than the following:] *Samples of the quantities indicated in Table I shall be crushed so that no pieces of coal and impurities will be greater in any dimension, as judged by eye, than specified for the sample before division into two approximately equal parts.*
>
> "[The sample delivered to the laboratory shall be not less than 10 lb. when crushed to $\frac{3}{16}$-in. or 4-mesh size. In case provision is to be made for duplicate laboratory samples, the same shall be taken from the remainder of the 30 lb. when crushed to $\frac{3}{16}$-in. or 4-mesh size.]
>
> "*The method of reducing by hand the quantity of coal in a gross sample shall be carried out as prescribed in Section 6. even should the initial size of coal and impurities be less than indicated in Table I.*"

5. *Section 6.*—Change to read as follows, by the insertion of the matter in italics and the omission of the matter in brackets.

> "6. [(*a*) When prepared by hand, the gross sample shall be reduced in quantity by stages; before each reduction, it shall be crushed to the fineness prescribed above and shall be thoroughly mixed. The following method shall be used in reducing the gross sample to approximately 250 lb.:] *The progressive reduction in the weight of the sample to the quantities indicated in Table I shall be done by the following methods, which are illustrated in Plate I.*[1]
>
> "(*a*) *The alternate-shovel method of reducing the gross sample shall be repeated until the sample is reduced to approximately 250 lb., and care shall be observed before each reduction in quantity that the sample has been crushed to the fineness prescribed in Table I.*
>
> "The crushed coal shall be shoveled into a conical pile (*Figs. 2 or 7, Plate I*) *by depositing each shovelful of coal on top of the preceding one*, and then formed into a long pile in the following manner: The sampler shall take a shovelful of coal from the conical pile and spread it out in a straight line (*Figs. 3A or 8A*) *having a width equal to the width of the shovel and a length of* 5 to 10 ft. [long.] His next shovelful shall be spread directly over the top of the first shovelful, but in the opposite direction, and so on back and forth, the

TABLE I.

Weight of Sample to be Divided, lb.	Largest Size of Coal and Impurities Allowable in Sample before Division, in.
[500] *1000* or over	1
[250] *500*	$\frac{3}{4}$
[125] *250*	$\frac{1}{2}$
[60] *125*	$\frac{3}{8}$
[30] *60*	$\frac{1}{4}$
[10] *30*	$\frac{3}{16}$ or 4-mesh screen

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[1] Plate I appears in the 1916 Volume of A.S.T.M. Standards.—ED.

pile being occasionally flattened, until all the coal has been formed into one long pile (*Figs. 3B or 8B*). The sampler shall then discard half of this pile, proceeding as follows:

"Beginning on one side of the pile, at either end, and shoveling from the bottom of the pile, the sampler shall take one shovelful (*shovelful No. 1*, *Figs. 4 or 9*) and set it aside; [advance] *advancing* along the side of the pile a distance equal to the width of the shovel, [and at this place] *he shall* take a second shovelful (*shovelful No. 2*) and discard it; again advancing in the same direction one shovel width, he shall take a third shovelful (*shovelful No. 3*) and add it to the first. The fourth (*shovelful No. 4*) shall be taken in a like manner and discarded, the fifth (*shovelful No. 5*) retained, and so on, the sampler advancing always in the same direction around the pile so that its size will be gradually reduced in a uniform manner. When the pile is removed, about half of the original quantity of coal should be contained in the new pile formed by the alternate shovelsful which have been retained. (*Figs. 5A or 10A show the retained halves, and Figs. 5B or 10B the rejected halves.*)

"(*b*) After the gross sample has been reduced by the above method to approximately 250 lb., further reduction in quantity shall be by the quartering method. Before each quartering, the sample shall be [thoroughly mixed and made into a conical pile as follows:] *crushed to the fineness prescribed in Table I.*

"Quantities of 125 to 250 lb. shall be [shoveled into a new conical pile by depositing each shovelful of coal on top of the preceding one] *thoroughly mixed by coning and re-coning* (*Figs. 12 and 13*); quantities less than 125 lb. shall be placed on a suitable cloth, measuring about 6 by 8 ft., mixed by raising first one end of the cloth and then the other (*Figs. 18, 24 or 30*), so as to roll the coal back and forth, and after being thoroughly mixed shall be formed into a conical pile by gathering together the four corners of the cloth (*Figs. 19, 25 or 31*). The quartering of the conical pile shall be done as follows:

"The cone shall be flattened, its apex being pressed vertically down with a shovel, or board, so that after the pile has been quartered, each quarter will contain the material originally in it. The flattened mass, which shall be of uniform thickness and diameter, shall then be marked into quarters *(Figs. 14, 20, 26 or 32)* by two lines that intersect at right angles directly under a point corresponding to the apex of the original cone. The diagonally opposite quarters *(BB in Figs. 16, 22, 28 or 34)* shall then be shoveled away and discarded and the space that they occupied brushed clean. The coal remaining shall be successively crushed, mixed, coned, and quartered until [two opposite quarters shall equal approximately 30 lb. of $\frac{3}{16}$-in. or 4-mesh size, from which the 10-lb. sample shall be taken and shipped to the laboratory in a suitable container.] *the sample is reduced to the desired quantity.*

"*(c) The 30-lb. quantity (Fig. 29) shall be crushed to $\frac{3}{16}$-in. or 4-mesh size, mixed, coned, flattened and quartered. The laboratory samples shall include all of one of the quarters, or all of two opposite quarters (Fig. 34), as may be required. The laboratory sample shall be immediately placed in a suitable container and sealed in such a manner as to preclude tampering.*"

6. *Section 8.*—Omit this section, which reads as follows, and re-number the remaining sections:

"8. If the accumulation of a sample extends over any considerable period of time, what would otherwise be a gross sample may be worked down in successive stages to samples of a size suitable for transmittal to the laboratory, and these fractional samples may be analyzed and the several analyses averaged; or the several samples may later be mixed at the place of sampling or in the laboratory and reduced to one sample, one analysis being made. In the averaging of analyses or in the mixing of the several samples, weights shall be used proportionate to the tonnages which the fractional samples represent."

This report has been submitted to letter ballot of the committee, which consists of 28 members, of whom 25 have voted affirmatively, 1 negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

G. S. POPE,
Chairman.

EDITORIAL NOTE.

The proposed Standard referred to in this report was approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appears in the 1916 Volume of A.S.T.M. Standards.

REPORT OF COMMITTEE D-6

ON

COKE.

Committee D-6 has held one meeting during the present year at Pittsburgh, Pa., which was attended by four members in person and two members by proxy.

In accordance with instructions received at the 1915 meeting of the committee, the Secretary reported a set of standard methods for analyzing coke which were drawn up and agreed to in conference with representatives of the Joint Committee on Coal Analysis of the American Society for Testing Materials and the American Chemical Society, and the Committee on Coke Analysis of the American Foundrymen's Association.

Inasmuch as Committee D-3 (formerly designated E-4) had already presented tentative methods for analyzing coal,[1] it was deemed desirable to confer with them and outline methods of coke analysis which should conform in so far as practicable with those methods, making due allowance for the differences in procedure that are desirable in the analysis of coke. The methods which were agreed to in the above conference were unanimously adopted by the members of Committee D-6 present at the meeting. Later these methods were referred to the whole committee for letter ballot, the vote being as follows: Affirmative, 13; negative, 2[a]; not voting, 1.

It is recommended (1) that the present Tentative Specifications for Foundry Coke[2] be referred to letter ballot of the Society for adoption as standard; and (2) that the appended[3] proposed Tentative Methods for Laboratory Sampling and Analysis of Coke be printed in the Proceedings as a proposed future addendum to the standard specifications.

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[1] "Tentative Methods for Laboratory Sampling and Analysis of Coal," 1915 Year-Book, p. 596.

[a] These two members approve the report and methods of analysis, with the exception of the allowable difference of 0.03 per cent in duplicate determinations of sulfur by the same analyst.

[2] 1915 Year-Book, p. 559.

[3] These Methods appear on pp. 551–563.—Ed.

This report has been submitted to letter ballot of the committee, which consists of 16 members, of whom 13 have voted affirmatively, 2[a] negatively, and 1 has refrained from voting.

Respectfully submitted on behalf of the committee,

RICHARD MOLDENKE,
Chairman.

A. C. FIELDNER,
Secretary.

EDITORIAL NOTE.

The proposed Standard referred to in this report was approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916, and appears in the 1916 Volume of A.S.T.M. Standards.

The proposed Tentative Standard referred to in the report was accepted for publication and appears on pages 551–563.

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[a] These two members approve the report and methods of analysis, with the exception of the allowable difference of 0.03 per cent in duplicate determinations of sulfur by the same analyst.

REPORT OF COMMITTEE D-7
ON
TIMBER.

The report of the committee is presented in two parts, devoted respectively to the work of two of its sub-committees on the subjects of (1) Douglas fir timber and (2) timber preservatives. The reports of the sub-committees to the main committee are presented in substantially the same form as originally submitted, followed by the recommendations of the committee with respect to matters affecting standards, together with an analysis of the vote by letter ballot of the committee on such recommendations.

SUB-COMMITTEE III ON PACIFIC COAST TIMBERS.

In cooperation with the officials of the United States Forest Service and the West Coast Lumbermen's Association, Sub-Committee III has during the past year been considering the possibility of formulating a specification for grading structural Douglas fir timbers upon a somewhat similar basis to the specifications adopted last year for southern yellow-pine timbers. The necessity for such a step is explained in Appendix I to this report.

After considerable correspondence a meeting was held in Seattle, Wash., at which specifications for structural Douglas fir timbers were discussed. It has been known for some time that the variation in weight per cubic foot and density found in Douglas fir results in considerable variation in strength. After a careful consideration of a number of specifications, the sub-committee has prepared Tentative Specifications for Selected Structural Douglas Fir Bridge and Trestle Timbers for consideration by the Society.

Committee D-7 recommends that these proposed tentative specifications, appended to this report,[1] be published among the Tentative Standards of the Society for one year. The vote by letter ballot of the committee on this recommendation is as follows: Affirmative, 27; negative, none; not voting, 9.

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[1] These specifications appear on pp. 479–482.—Ed.

SUB-COMMITTEE VI ON TIMBER PRESERVATIVES.

Sampling of Creosote Oil.—In 1915 tentative methods for taking continuous drip sample and storage tank samples were recommended.[1] Sub-Committee VI recommended that tank-car sampling receive the attention of a special joint committee of various interested organizations. Such an undertaking was brought about through the initiative of the American Railway Engineering Association, by a joint committee representing that organization, the American Wood Preservers' Association, and this Society. The report of the joint committee was presented to the American Railway Engineering Association by its Committee on Wood Preservation in March, 1916. The following is the report as submitted:[2]

REPORT OF JOINT COMMITTEE
ON
WATER SAMPLING IN CREOSOTE OIL.

During the past year the committee has given further attention to the question of developing a standard method for determining the percentage of water contained in creosote oil when shipped in tank cars.

The sampling of liquids in tank cars is an exceedingly difficult matter; in fact, a special committee of the American Society for Testing Materials reported that it had been unable to find any method which could be recommended for obtaining satisfactory samples of liquids when shipped in tank cars. After much consideration, the committee finally decided to carry on a series of tests with various methods for sampling. These tests were carried on under the auspices of the committee with the cooperation of similar committees, at the request of the chairman, of the American Society for Testing Materials and the American Wood Preservers' Association.

The committee wishes at this point to express its acknowledgment for the very valuable assistance, in carrying on the tests and in preparing the report, of Mr. S. R. Church, of the Barrett Manufacturing Co., and of Mr. E. B. Fulks, of the American Tar Products Co.

Under the direct supervision of the Sampling Committee, two tank cars were loaded with creosote oil at the Shadyside, N. J., plant of the Barrett Manufacturing Co., December 22, 1915, shipped to Federal Creosoting Co. plant at Rome, N. Y., and unloaded at that point on January 3, 1916. Samples were taken by various means and afterwards divided into three sets. One set of samples was tested in the laboratory of von Schrenk & Kammerer, another in the laboratory of the Port Reading Creosoting Plant, and the third in the laboratory of the Barrett Manufacturing Co. This report comprises a description of the manner of loading and unloading the cars and sampling of same.

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[1] "Tentative Methods for Sampling and Analysis of Creosote Oil," 1915 Year-Book, p. 625.

[2] From *Bulletin No. 184*, Am. Rwy. Eng. Assoc., pp. 447–456.

In accordance with the prearranged plan, one car was loaded with substantially dry oil, and a measured volume of water added to the car from a separate source, and the other car was loaded with oil containing about 7 per cent of water. The two cars, GATX 4480 and APTX 52, each had a marked capacity of 8043 gal., and inside shell diameter of 82 in. Before loading, the cars were cleaned and the steam coils tested. The procedure was as follows:

Car GATX 4480.—The oil was pumped from storage tank to car by the plant service pump, and a continuous drip sample taken in accordance with method described in the Tentative Methods for Sampling and Analysis of Creosote Oil of the American Society for Testing Materials.[1] Four hundred and fifty-two gallons of water were run in by gravity from a measuring drum having an exact capacity of 113 gal. The flow of water was timed so that it coincided with the flow of oil. The water entered through a 2-in. pipe directed so that the stream of water entered and mingled with the stream of oil. The car was loaded so that the oil level was in the dome. Temperature of oil in car immediately after loading was 126° F. Samples were immediately taken at points one foot from the top, at the center, and one foot from the bottom of the car, as ordinarily practiced at this plant.

The sampling vessel, hereafter referred to as a bottle, consisted of a 1-qt. metal can, weighted with lead, and stoppered with a cork, to which was attached a cord for withdrawing the stopper at any desired level.

One hour and 40 minutes after loading the car the temperature of the oil was 105° F. A sample was taken at the top of the car by a cross-section sampler, consisting of a glass tube 2 ft. long, closed by a valve at the bottom. (This type of sampler is used to a considerable extent in attempting to estimate the free water on the top of cars.) The tube showed 9 in. of free water, of which 5 in. was in the dome and 4 in. in the car proper.

Zone samples were then taken from levels representing centers of 1-ft zones from top to bottom of the car. For this purpose two devices were used, one being the bottle already described, and the other the Braun sampler. The latter consists of a small cylinder of about 200-cc. capacity, attached to a jointed tube having a total length of about 9 ft., with an inner tube operating a valve at the bottom of the cylinder, the outer tube acting as an escape pipe, so that when the sampler is opened air is released without disturbing the contents of the car. Owing to the small capacity of this device, it was necessary to take four samples at each level in order to obtain sufficient oil for testing, and it was noticed while transferring the oil from the sampler to the sample can that a considerable amount of water and oil, which adhered to the surface of the rod when the sample was withdrawn, ran down the rod and into the can during the discharge of the sample.

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[1] 1915 Year-Book, p. 625.

Car ATPX 52.—The wet oil, which had previously been transferred from a storage tank to a tank car in order to be available when desired, was pumped into Car 52 by means of temporary pump and pipe line connection, and a continuous drip sample taken during the pumping. When the car was loaded the oil level was in the dome. The temperature of the oil immediately after loading was 130° F. Samples were then taken from top, center and bottom by the bottle method, as usual, but no further sampling of this car was done at Shadyside.

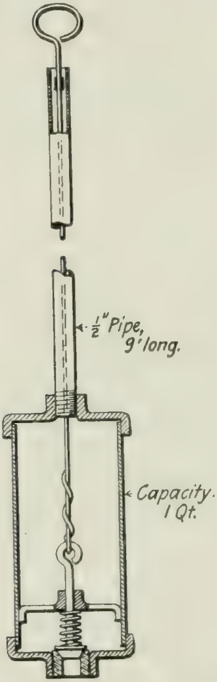

FIG. 1.—Tank Car Sampling Device.

The cars arrived at Rome, N. Y., on December 30. They were placed on the unloading track. At this plant the cars discharge by gravity into a tank directly below the track, the oil running from the tank car outlet into a large funnel.

The procedure at Rome was as follows:

No steam was placed in the coils of the cars until 7.30 a. m. on January 3.

At this time the oil had solidified in both cars. After three hours' heating, the contents of both cars were perfectly liquid.

Car GATX 4480.—The temperature of the oil in the car was 122° F. The oil level in this car was exactly the same as at Shadyside, namely, 5 in. of oil in the dome. The cross-section sample from top by the 2-ft. glass tube showed practically no separation between oil and water. One-foot zone samples were taken by a device similar in principle to the Braun sampler used at Shadyside, the latter having been discarded as inadequate. The construction of the sampler used at Rome is roughly indicated in Fig. 1. Samples were taken at top, center and bottom with the bottle sampler. The car was then sampled by the Federal Creosoting Co. in the manner ordinarily practiced at that plant, using a thief sampler, consisting of a tin cylinder about 2 ft. long, 3 in. in diameter, with a 1-in. hole in the top. This was lowered quickly to the bottom, and raised slowly in such a way that it was not quite full when removed. The oil was then discharged from the car by gravity, and a dipper sample was taken from the open stream, taking about a pint of oil every five or six minutes. In this way about a 2-gal. sample was collected, of which an average sample was finally taken.

Car ATPX 52.—The procedure in sampling Car 52 was identical with that described for Car 4480. The temperature of oil was 117° F. The oil level was about ½ in. below the dome.

In Table I is a list of the samples which were marked consecutively as taken at Shadyside and Rome, and the results of water determinations on these samples at the laboratories of von Schrenk & Kammerer, the Port Reading Creosoting Plant and The Barrett Manufacturing Co.

In order to present the results in graphic form a drawing is appended (Fig. 2), showing vertical cross-sections through each car. On this drawing we have indicated the points at which various samples were taken, the device by which they were taken and the results of the water test. On this drawing the results are those obtained in the laboratory of the Barrett Manufacturing Co.

It will be noted that the figures given for water found for the different zone samples are calculated according to factors found on the drawing appended to this report (Fig. 3). The actual percentage of water found in any zone does not correctly represent the real percentage, because the number of gallons found in the different zones differ because of the shape of the tank car. The percentage of water found in each zone should be multiplied by the percentage (shown at the left of Fig. 3), representing the relation of this zone to the entire car. In other words, take the diameter of the car, marked as abscissas in Fig. 3, run up on the vertical line to the zone line, and from this point across horizontally to the left-hand side, the figure read there expressing the percentage relation. The sum of the results obtained for this calculation for the samples from the different zones represents the total percentage of water in the car.

It will be noted that the results obtained by the various methods of sampling from Car 4480, which contained dry oil to which water was deliberately added, varied widely, but on the other hand, the tests on wet oil contained in Car 52 are quite uniform. The committee observed that the water separated rapidly from the oil in Car 4480, so that indeed there was more free water on the surface of the oil within two hours after loading than there was at the time of unloading. Evidently the water and oil had become mixed

TABLE I.—WATER TESTS ON SAMPLES OF CREOSOTE OIL.

Sample No.	Taken in Connection with Car No.	Description of Sample.	Percentage of Water.		
			Barrett Mfg. Co.	von Schrenk & Kammerer.	Port Reading Creosoting Plant.
		SHADYSIDE SAMPLES.			
1	4480	Drawn from Storage Tank 45 before loading car..	0.10	0.2	0.36
2	4480	Continuous drip sample taken while loading car..	0.9	0.8	0.9
3	4480	Bottle sample from top of car..................	14.0	11.6	13.3
4	4480	Bottle sample from center of car..............	5.3	6.0	5.0
5	4480	Bottle sample from bottom of car..............	6.5	5.6	6.1
6	4480	Cross-section sample from top 2 ft. of car.......	54.8	58.5	53.2
7	4480	One-foot zone samples by Braun sampler, Zone 7	74.5	...	...
8	4480	" " " " " " " 6	8.0	...	...
9	4480	" " " " " " " 5	10.0	...	...
10	4480	" " " " " " " 4	6.5	...	...
11	4480	" " " " " " " 3	6.6	...	...
12	4480	" " " " " " " 2	9.8	...	...
13	4480	" " " " " " " 1	14.1	...	...
14	4480	Bottle zone sample, Zone 7....................	37.1	37.9	36.3
15	4480	" " " " 6....................	3.5	4.9	4.2
16	4480	" " " " 5....................	2.0	2.1	2.2
17	4480	" " " " 4....................	1.9	2.2	1.7
18	4480	" " " " 3....................	2.5	1.9	1.9
19	4480	" " " (bottom).................	6.4	7.4	6.7
20	52	Continuous drip sample from loading car..... ...	7.4	7.7	7.1
21	52	Bottle sample from top of car..........	6.1	5.8	5.0
22	52	Bottle sample from center of car........	5.9	7.7	6.8
23	52	Bottle sample from bottom of car.......	12.0	13.6	11.1
		ROME SAMPLES.			
24	4480	19-in. cross-section sample.........................	79.0	...	...
25	4480	Cylinder one-foot zone sample, Zone 7..........	35.0	37.0	34.0
26	4480	" " " " " 6..........	4.0	4.9	4.2
27	4480	" " " " " 5..........	4.0	4.4	3.2
28	4480	" " " " " 4..........	3.0	2.1	2.2
29	4480	" " " " " 3..........	2.0	2.0	1.4
30	4480	" " " " " 2..........	5.6	4.2	4.6
31	4480	" " " " " 1..........	5.0	4.3	3.4
32	4480	Bottle sample from top of car..................	7.3	7.2	6.3
33	4480	Bottle sample from center of car...............	4.5	5.0	4.5
34	4480	Bottle sample from bottom of car.............	4.0	4.6	3.5
35	4480	Federal Creosoting Co. thief....................	12.6	15.0	14.0
36	4480	Dipper sample..................................	15.0	19.5	14.5
37	52	19-in. cross-section sample.....................	13.7	...	...
38	52	Cylinder 1-ft. zone sample, Zone 7..............	7.5	7.5	7.5
39	52	" " " " " 6..............	8.1	8.0	7.4
40	52	" " " " " 5..............	8.8	8.0	7.2
41	52	" " " " " 4..............	8.0	7.2	7.1
42	52	" " " " " 3..............	8.0	8.1	6.6
43	52	" " " " " 2..............	9.0	7.4	7.0
44	52	" " " " " 1..............	10.8	10.2	9.8
45	52	Bottle sample from top of car..................	8.0	7.7	7.8
46	52	" " " center of car..............	8.0	8.1	7.4
47	52	" " " bottom of car.............	9.5	8.9	8.0
48	52	Federal Creosoting Co. thief....................	7.9	8.5	7.2
49	52	" " " "	9.3	7.4	7.2
50	52	Dipper sample.....	8.0	8.7	7.2
51	52	" "	8.0	9.7	8.0

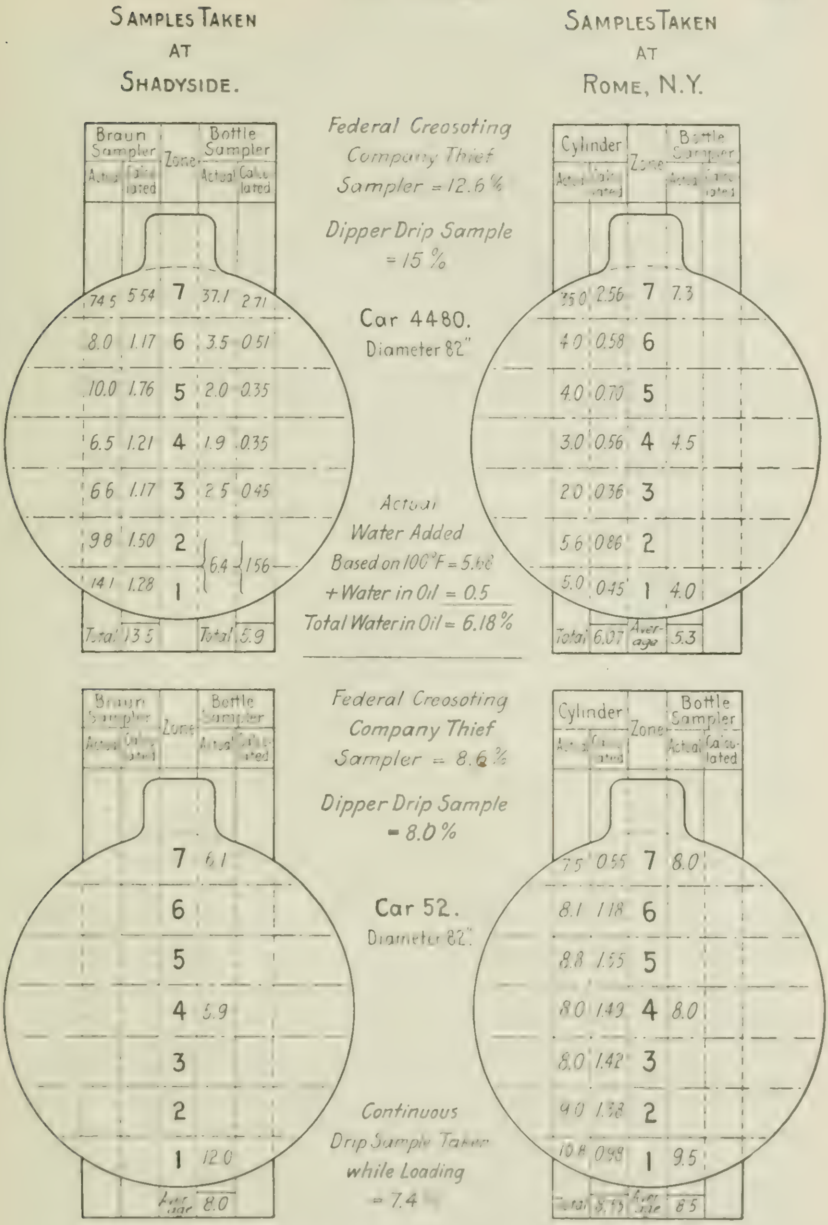

FIG. 2.—Water Tests on Samples of Creosote.

Actual percentages are taken from Table I, Barrett Manufacturing Co. Calculated percentages are determined according to factors found **from Fig. 3.**

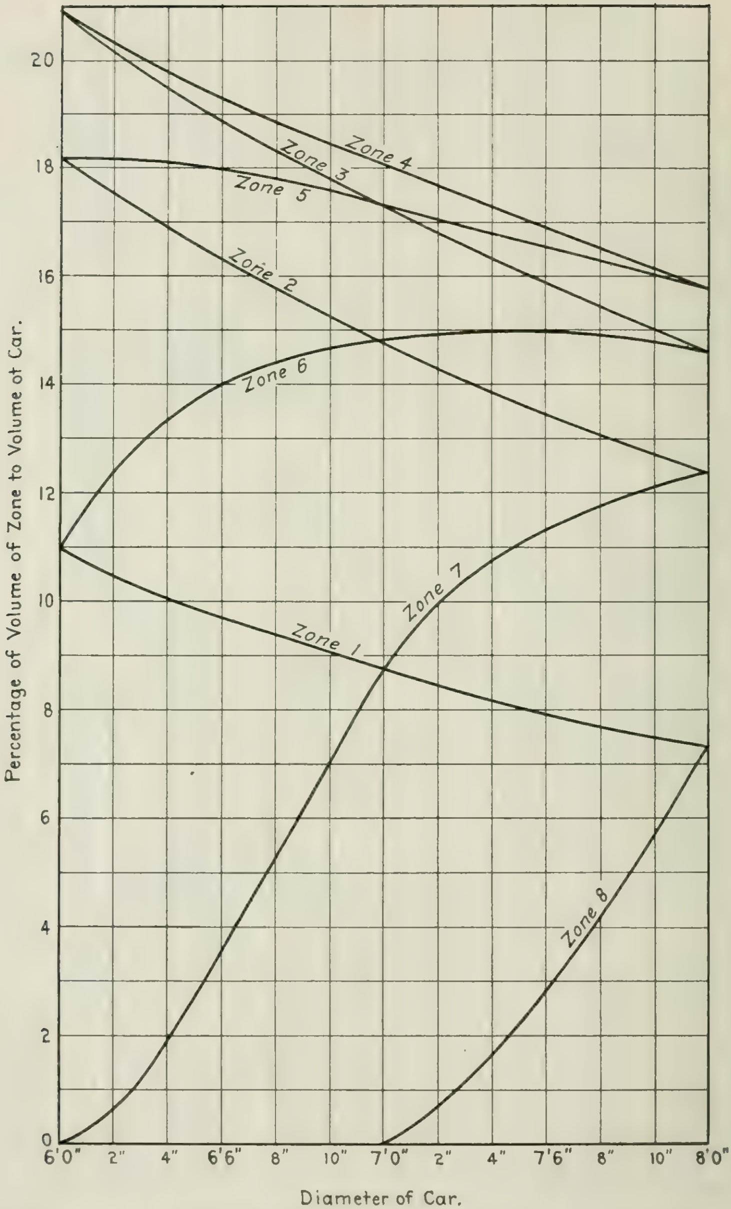

FIG. 3.—Curves Showing Weights to be Given Samples from Different 1-ft. Zones, Measured and Numbered from Bottom up, of Various Sizes of Tank Cars.

during transit and the water did not again separate so rapidly from the oil. With Car 52, on the other hand, there was no apparent separation of water and oil, even though this oil contained more water than the other. It is obvious, of course, that the partial separation of oil and water, such as took place in Car 4480, makes sampling more difficult than when the water is uniformly distributed throughout the oil.

CONCLUSIONS.

The tests described above and the results obtained are presented as a progress report. The following preliminary conclusions have been drawn by the committee:

1. That for accurate determination of water in a tank car of creosote, a system of sampling from several zones in a car is necessary. These zones must represent definitely calculated areas throughout the entire depth of the car. There must be at least three zones, the top, the middle and the bottom of the car. The indications are that for the most definite determinations zones 1 ft. deep are to be preferred (see Fig. 2).

2. That for calculating any percentage of water found in any zone in relation to the proportion to the entire car, the correction factor indicated in Fig. 3 be used.

3. That the cross-section tube frequently used for taking samples from tank cars is of little value. It disregards the fundamental principle of zone sampling, in that it takes no account of the proportionate value of the sample taken with reference to the whole car. It, furthermore, cannot be used in connection with zone sampling without much additional computation.

4. The so-called thief[1] has been found incorrect in theory, and the results obtained therewith confirm this.

5. That the taking of a dipper or bucket sample from the running stream of cars while discharging does not give reliable results, and that this method should not be used.

6. That the bottle method, meaning the use of a small stoppered vessel from which the cork can be withdrawn at any desired level, is a convenient apparatus for taking zone samples. Its disadvantage lies in the fact that escaping air, after the withdrawal of the cork, tends to disturb the surrounding oil, and therefore gives an incorrect sample.

7. That for the present an apparatus, the principle of which is shown in Fig. 1, be used for zone sampling in taking samples from cars in which a high percentage of water is suspected. It should be understood that the appended sketch is merely to show the general plan of the sampler.

8. That efforts be made to construct an improved form of the sampler just referred to, provided further tests warrant a definite recommendation for its use.

9. That for ordinary purposes the taking of three zone samples, that is from the top, the middle and the bottom of a car, by means of the apparatus, just referred to or by means of a bottle device, is recommended.

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[1] *Proceedings*, Am. Rwy. Eng. Assoc., Vol. 16, p. 831 (1915).

10. That the tests described this year be considered preliminary and that similar tests be made at various treating plants and tar plants during the coming year. Care should be taken to make such tests to include both summer and winter shipments.

Committee D-7 recommends that the foregoing report be printed in the Proceedings as information.

Sampling of Fused Zinc Chloride.—Sub-Committee VI reported last year that it had been unable to arrive at any recommendation with reference to a method for sampling fused zinc chloride. The sub-committee has given further attention to this matter, but can only report progress on the problem, and hopes that a method will be agreed upon and presented to the Society next year.

Analysis of Creosote Oil.—Last year tentative methods for distillation test and specific-gravity test of creosote oil were recommended.[1] In continuance of this work the committee presents additional recommendations for the specific-gravity test, and a tentative method for the determination of insoluble matter. The method for the determination of tar acids is under consideration, but cannot be presented at this time, because of lack of opportunity for members of the Sub-Committee VI to confirm the accuracy of the method.

1. *Specific-Gravity Test.*—Committee D-7 recommends that the proposed revision of the specific-gravity test in the Tentative Methods for Sampling and Analysis of Creosote Oil, contained in Appendix II to this report, be approved by the Society.

2. *Specific Gravity of Fractions.*—It is frequently required that the specific gravity be taken of certain fractions of oil distilling between specified temperatures. As specific gravity is an absolute determination, any accurate method may be followed. In the opinion of Sub-Committee VI, determinations by the usual type of pyknometer or specific-gravity bottle are apt to be inaccurate, because of the difficulty of standardization. The following methods are recommended as applicable to the determination of specific gravity where the quantity at hand is small:

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[1] "Tentative Methods for Sampling and Analysis of Creosote Oil," 1915 Year-Book. p. 625.

METHODS FOR DETERMINATION OF SPECIFIC GRAVITY OF FRACTIONS.

Method for Liquid Fractions.—If the fraction to be tested is liquid at a temperature not exceeding 60° C., the Westphal balance can be used with convenience and rapidity. A special type of Westphal balance is obtainable, designed for testing very small quantities. However, the ordinary type Westphal balance can be adapted to testing small fractions by the use of a special plummet. This can be readily made in the laboratory from a piece of ordinary glass tubing about 7 mm. outside diameter, sealed at one end, and melting into the glass where sealed a short platinum wire. After cooling, place 9 to 10 g. of mercury in the tube, making a column 35 to 40 mm. high. Seal

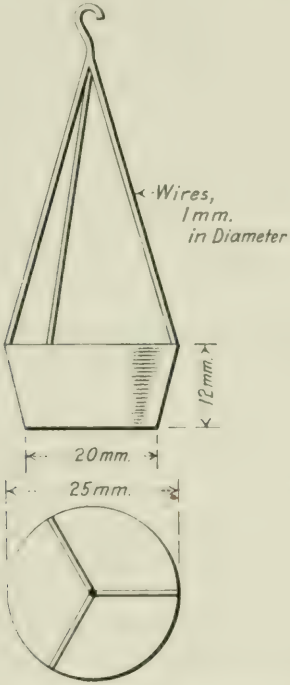

FIG. 4.—Weighing Pan for Determining Specific Gravity.

off the tube within 20 mm. of the top of the mercury column with blowpipe flame. The plummet should have a length of about 55 to 60 mm. overall, and should weigh between 10 and 12 g.

Method for Solid and Semi-Solid Fractions.—For the determination of fractions that are solid or semi-solid and cannot readily be liquefied at a temperature not exceeding 60° C., a weighing pan constructed of platinum or nickel (Fig. 4) may be used. A pan of convenient dimensions is 20 mm. diameter at the base and 25 mm. diameter at the top, and about 12 mm. deep. It is made of platinum and supported by three platinum wires 1 mm. in diameter, and has a total weight of about 7 g. Solid or semi-solid fractions of oil can be rapidly and accurately tested in this apparatus by the usual method of weighing in air and in water. The usual precautions of igniting the pan before use, avoiding the enclosure of air or water in the sample, should be observed.

Committee D-7 recommends that the foregoing methods be published in the Proceedings as information. This is believed to be particularly desirable, in view of the absence from existing specifications for creosote oil of any instructions with reference to methods for determining specific gravity of fractions.

3. *Determination of Insoluble Matter in Creosote Oil.*—Almost all specifications for creosote oil contain a requirement relative to the allowable percentage of insoluble matter. The method for determining the insoluble matter present is rarely specified. The method which Sub-Committee VI has decided to recommend is hot extraction of the oil with benzol. This method is already in use in the laboratories of the principal producers and consumers of creosote oil. It involves no new principle, as hot extraction is at present required in the majority of specifications. It is important, however, that a standard method should be described in some detail, as the test is an empirical one, and comparable results can only be obtained by uniformity of practice.

Committee D-7 therefore recommends that the method for determination of insoluble matter given in Appendix II to this report be received as tentative and included in the Tentative Methods for Sampling and Analysis of Creosote Oil published in the 1915 Year-Book, which the committee recommends be retained as tentative.

The vote by letter ballot of the committee on the recommendation relative to the Tentative Methods for Sampling and Analysis of Creosote Oil is as follows: Affirmative, 22; negative, none; not voting, 14.

This report has been submitted to letter ballot of the committee, which consists of 36 members, of whom 29 have voted affirmatively, none negatively, and 7 have refrained from voting.

Respectfully submitted on behalf of the committee,

HERMANN VON SCHRENK,
Chairman.

EDITORIAL NOTE.

The two proposed Tentative Standards referred to in this report were accepted for publication, and appear on pages 479–482 and 564–571.

On the recommendation of the committee, the Tentative Specifications for Southern Yellow-Pine Timber to be Creosoted and the Tentative Specifications for Southern Yellow-Pine Piles and Poles to be Creosoted, each as published in the 1915 Year-Book, were continued as tentative and appear on pages 483–486.

The proposed Tentative Specifications for Wooden Paving Blocks, originally included in the report of the committee, were withdrawn by the committee for further consideration.

APPENDIX I.

THE NEED OF A QUALITY CLASSIFICATION FOR DOUGLAS FIR.

By J. A. Newlin.

A generally prevalent idea among those handling Douglas fir is that this species does not need a quality classification. It is generally admitted that a quality classification for the southern yellow pines is necessary, since, in the minds of many, such a classification is required through the difficulty of differentiating the lumber of the several pines that grow, more or less intermixed, in our Southern states. Many still insist that, given a method of distinguishing the timber of true longleaf pine from that of the other closely related species, no quality classification would be necessary, since that species is surpassed by none in the quality of its structural material.

Tests have shown, however, that clear pieces of true longleaf pine may be found that are lower in strength than the average clear pieces of the most inferior species used for structural purposes, and with less than three-fourths the strength of the average loblolly and shortleaf pine. The variation in the quality of true longleaf is so great that individual pieces, when tested in the form of small clear beams, are more than three times as strong as others. This alone ought to show that had true longleaf been the only species of pine in the South, a quality classification would have been extremely desirable.

Variations in strength, equal to that of longleaf pine, have not yet been found in the other southern pines or Douglas fir, but this is probably the result of a wider and closer examination of longleaf pine for pieces representing extremes of strength. However, note has been taken of variations in the bending strength of Douglas fir (in which no especial effort was made to select the material) as great as 1 to 2.5 (see Fig. 1). This, of itself, ought to lead to the belief that a quality classification of Douglas fir is a necessity.

Cause of Variations in Quality.—Variations in quality are primarily due to a difference in the amount of wood substance in a given volume. All wood substance has about the same density, regardless of species, its density running from 1.5 to 1.6. Some rare species do not have more than one-fifteenth of their volume composed of wood substance; whereas, in occasional pieces of some of our denser native woods it forms as much as two-thirds of their volume. It may then be seen that, aside from deposits of resin or other similar substances, varia-

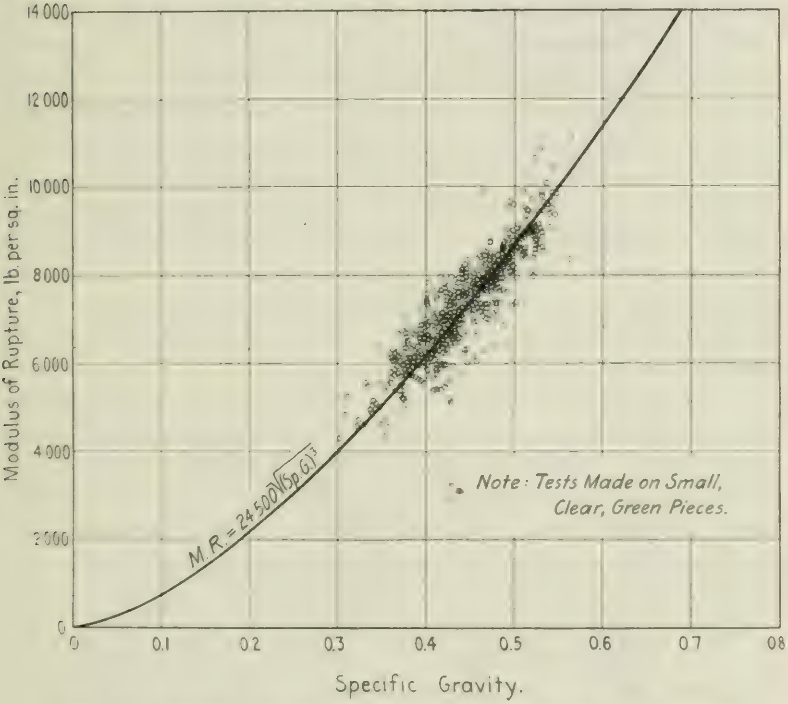

FIG. 1.—Relation between Bending Strength and Dry Weight for Douglas Fir.

tions in the dry weight, or density, of wood are principally due to variations in the amount of wood substance present. It can therefore safely be assumed that low density can never be accompanied by great strength; an assumption that is confirmed by all tests of timber. This is exemplified, in the case of Douglas fir, by Fig. 1. On the chart in this figure each point represents a small, clear stick that has been tested as a beam, and marks the intersection of the lines through specific gravity (exclusive of moisture) and modulus of rupture for that particular piece. The chart shows plainly that if the derivation of safe working stresses as given by Betts[1] is followed, some Douglas fir is too weak to be allowed under a working stress of 1600 lb. per sq. in. (desirable for the major portion of Douglass fir), even when clear of all defects. It is also true, from observation, that a considerable quantity of this low density, weak fir in the form of railway bridge stringers and other heavy timbers in which great strength and reliability were essential, has been shipped to various parts of the country, under the impression that it was good quality material.

Species of the same average weight do not show exactly the same properties; nor do all pieces of a given species of the same density exhibit exactly the same strength. This is also illustrated in the figure, where the points on any vertical line have the same density, but different strengths. Differences in wood structure, such as the arrangement of cells and fibers, etc., exert influences which cause relatively small variations in the strength properties of species of the same average weight.

The variation in most of the strength properties of wood is greater than the variation in density. This is also illustrated in the figure, where the curve, which is an average line through the origin and all the points, becomes increasingly steeper. In general, it may be stated that when two pieces are found, one of which is twice as dense as the other, the difference in bending strength will usually be approximately as 3 to 1.

Summer Wood as a Criterion of Density.—A knowledge of the variation of strength with density, without rapid and simple methods of determining density, would be of little value in selecting structural timber. Fortunately, the southern pines and Douglas fir offer an excellent visual criterion of density in the percentage of summer wood in the timber. This method of estimating density, and, therefore, quality, for the Southern pines, was discussed in the papers of Messrs. Betts and Swan.[1] The same method is generally applicable to Douglas fir; but, in order to check it thoroughly, a field study has been inaugurated, which will especially determine what portions of the cross-sections of Douglas fir timbers give representative measurements of summer wood. Check tests upon structural sizes will also be made before the Forest Service gives its final endorsement of the proposed method.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, p. 369 (1915).

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XV, Part I, pp. 369-401 (1915).

APPENDIX II.

PROPOSED REVISIONS
IN
TENTATIVE METHODS FOR SAMPLING AND ANALYSIS OF CREOSOTE OIL.[1]

Specific Gravity Test.

Committee D-7 recommends that the following two sentences in Section 8 of the Tentative Methods for Sampling and Analysis of Creosote Oil referring to the test for specific gravity, namely:

> "The reading should preferably be taken at 38° C. (100° F.), because at this temperature almost all oils are completely fluid. . . . If the specific gravity is determined at a higher temperature than desired, correction should be made by adding 0.0008 to the reading for each degree Centigrade excess of temperature.",

be changed to read:

> "The oil shall be brought to a temperature of 38° C. (100° F.), and the determination shall be made at that temperature unless the oil is not entirely liquid at 38° C. In case the oil requires to be brought to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by adding 0.0008 to the observed specific gravity for each degree Centigrade above 38° C. at which the test is made. This correction factor does not apply with equal accuracy to all oils, but serious error due to its use will be avoided if the foregoing precaution is observed, with respect to avoiding unnecessarily high temperature."

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[1] 1915 Year-Book, p. 625.

DETERMINATION OF INSOLUBLE MATTER.

Committee D-7 recommends that the following method for determination of insoluble matter in creosote oil be accepted by the Society as tentative and included in the Tentative Methods for Sampling and Analysis of Creosote Oil:

Apparatus.

1. (*a*) *Extractor.*—The extractor may be of the form shown in Fig. 1, or any similar form in which the oil is subjected to direct washing by the boiling vapors of the solvent.

(*b*) *Filtering Medium.*—The filtering medium may be either two thicknesses of S. & S. No. 575 hardened filter paper, 15 cm. in diameter, arranged in cup shape by folding symmetrically; or alundum thimbles, flat bottom, 30 x 80 RA 98. If filter papers are used, prior to using they shall be soaked in benzol to remove any grease, dried in a steam oven and kept in a desiccator until ready to be used. The filter-paper cup may be suspended in the extractor flask by a wire basket hung from two small hooks on the under surface of the metal cover of the flask. If the alundum thimble is used it may be supported by making two perforations in the top of the thimble, and suspending from the cover by German silver or platinum wires.

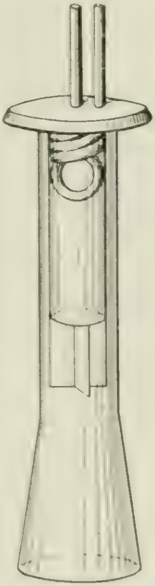

FIG. 1.—Extraction Flask, showing German Silver Wire Support for Filter Papers.

Tests.

2. Weigh 10 g. of dry oil in 100 cc. beaker. Add about 50 cc. of pure benzol and transfer at once to the filter cup. The filter cup or thimble is previously weighed, and the paper cup shall always be kept in a weighing bottle until ready for use. Wash out the beaker with benzol, passing all washings through the filter cup, and place latter at once in the extraction apparatus. Extractor shall contain a suitable quantity of pure benzol. Sufficient heat to boil the solvent shall be provided by means of an electric heater or a steam bath. Continue the extraction until the descending solvent

is practically colorless, and remove the filter cup and dry in steam oven until all solvent is driven off; cool in desiccator and weigh. The balance used for this purpose should be accurate to within 0.5 mg.

REPORT OF COMMITTEE D-8
ON
WATERPROOFING.

At the 1915 annual meeting of the Society, an informal statement was made by the chairman of this committee, that it then expected to submit specifications at the next annual meeting. While the outlook a year ago seemed to warrant that statement, our work has been materially and unavoidably delayed by later developments resulting in the radical reorganization of the most important sub-committee of Committee D-8, namely, Sub-Committee V, upon which is imposed the bulk of the work of preparing the proposed specifications, and also by the inability of several other sub-committees to collect information covering general specification practice for waterproofing engineering structures of typical classes. With the appointment of a new chairman of Sub-Committee V, and an increased membership, a program has been developed. A preliminary report, embodying five proposed specifications, was presented at a meeting of Committee D-8 on January 26, 1916. These specifications included methods of testing for several materials used in foundations and other construction, tentatively described as applying to "below-grade" conditions. The program further contemplated the preparation of specifications for similar materials applied to "above-grade" conditions, as, for example, bridge floors, etc., as well as conveying media other than felt, the only one actually specified in the report.

This preliminary report of Sub-Committee V was received, and at the request of that sub-committee, was referred back with instructions to complete the proposed specifications as expeditiously as possible.

At a meeting of the committee held on May 12, 1916, proposed specifications for coal-tar pitch and asphalt for use under conditions tentatively described as "below-grade," as well as specifications for creosote oil for use as a priming coat for coal-tar pitch, were decided upon in all their essential features, and during the coming year the committee will write the specifications in a form suitable for presentation to the Society at the next annual meeting.

The proposed specifications for coal-tar saturated felt, and for asphalt-saturated or coated felt, are not in as satisfactory shape as those for the other materials, but it is anticipated that the differences will soon be reconciled.

This report has been submitted to letter ballot of the committee, which consists of 27 members, of whom 25 have voted affirmatively, none negatively, and 2 have refrained from voting.

Respectfully submitted on behalf of the committee,

W. A. AIKEN,
Chairman.

REPORT OF COMMITTEE D-10
ON
SHIPPING CONTAINERS.

Committee D-10 on Shipping Containers was organized by the Executive Committee of the American Society for Testing Materials on October 6, 1913, with Col. B. W. Dunn appointed as temporary chairman.

As this committee has not made any previous report to the Society, a brief statement of the progress made and the meetings held will not be out of place.

On December 8, 1913, a list of members of the committee was sent to the temporary chairman. Of the 19 members, 9 were producers and 10 non-producers of shipping containers. It was proposed to increase the number of members from time to time when any competent person could be found who was willing to serve.

The committee met in New York City on January 8, 1914, for organization with 17 members present. Col. B. W. Dunn was elected permanent chairman for the regular period and the committee proceeded to discuss the policies and methods of work to be followed. It was decided that the first step should be the preparation of a list showing the names of all shipping containers in use, and the second, to compile all obtainable information as to specifications already prepared for their manufacture. This accomplished, sub-committees should be appointed to make a study of each container in the list, to become familiar with its manufacture and with the relative efficiency and costs of the different grades in use.

A sub-committee was appointed to prepare a list of all the containers in use.

The second meeting of the committee was held at Atlantic City on July 22, 1914. The work had progressed sufficiently only to show more clearly than ever its great magnitude. It had been found necessary to list the containers in classes and 35 classes of containers had been so listed. In some of these there were many sub-classes, thus largely increasing the variety of the work. Some of the most important containers had been assigned to investigating sub-committees and much work had been done. No definite results had been obtained, however, nor was there any reasonable prospect of their being obtained promptly. The reports of the various members in regard to their activities and experiences showed the necessity for the standardization of shipping containers and of tests to determine the standards.

The third meeting of the committee was held November 13, 1914, in Chicago, and was a direct result of the investigation with regard to boxes and the necessity of providing tests of a standard nature by which the efficiency of a box could be determined. The tests along these lines in the past, so far as could be learned, had been extremely few and almost invariably inadequate and inconclusive. The comparison of different kinds of boxes and determination of their good and weak points, however, rendered the application of tests of various kinds absolutely necessary. In the course of our work a testing machine had been developed by Mr. W. A. Fairburn and also one by Mr. G. C. Babcock, both members of this committee, and experiments with the Babcock machine were witnessed by the committee during the meeting. The necessity for tests and the results of the experiments suggested that an organized investigation on the subject would be advisable and a sub-committee was appointed for that purpose. Funds for such investigation being necessary, it was agreed by representatives of the National Association of Box Manufacturers, The Wirebounds Corporation and the Fiber and Corrugated Strawboard Box Associations, who were members of our committee, that they would take care of the necessary expense. Both of the machines developed were to be investigated and data as to their use accumulated. They were to be improved and other machines and tests added if found desirable and possible.

It was decided during this meeting not to make any report to the Society in 1915 for the reason that the details of the work had not progressed to a point where definite specifications could be prepared. It was becoming increasingly evident that the committee had enough work in this development of tests and specifications to occupy its time for many years; but the forms of future specifications were gradually becoming evident.

The next meeting of the committee was on June 23, 1915, at Atlantic City. Reports indicated that the accumulation of information and data was progressing slowly but surely. The problem of devising testing machines had for the time obscured the work on specifications and the difficulty as well as the importance of its solution necessitated the expenditure of much time even though other subjects were being temporarily neglected. The original testing machines had not proved as satisfactory as was expected but it was shown that future development would probably enable their defects to be rectified.

Without doubt, the most important development of this meeting was the information that the U. S. Department of Agriculture, through the Forest Products Laboratory at Madison, Wis., was willing to cooperate extensively with Committee D-10 in its work in connection with the development of tests for containers. As a measure of conservation it was considered that tests for the purpose of determining how our forest products could be used to the best advantage, whether in the making of containers or otherwise, was essentially a part of the work of this laboratory. The laboratory was already represented on the committee by Mr. J. A. Newlin, who stated that aside from the expense of the testing machine and containers for test, he was authorized to say that the laboratory would be glad to give its services and it was arranged that a machine should be built under his direction and developed by tests made at Madison, Wis.

We can now come down to the conditions at the present time in regard to the work of the committee. We have 29 members, of whom 13 are assigned as individual investigators to gather and compile data as to the various types of containers. In some cases sufficient data have already been obtained so that it appears probable that regular sub-committees can be appointed in the near future for its consideration. We have two regular sub-committees assigned to the testing problem and to other work.

The testing sub-committee in connection with the Forest Products Laboratory has further developed one of the testing machines to an extent such that when it is used in connection with direct pressure tests, etc., as may be necessary, it should give efficient and satisfactory results. While the standards of the machine, or, the extent to which a satisfactory container must stand its treatment, have not as yet been conclusively fixed, the machine has been used to develop tentatively the requirements of one set of specifications.

TYPE OF TESTING DEVICE.[1]

Previous to beginning work on the present machine members of the sub-committee had constructed and used a revolving cylindrical drum-box testing machine. The drum was about 4 ft. long. The box to be tested was placed in the drum and the drum rotated. On the sides of the drum were inclined guides whose function was to shift the box from end to end and drop it from side to side of the drum. This machine brought out clearly some of the defects of various box designs but was not entirely satisfactory. The tendency was for the box to roll over and from endwise to sidewise, depending on how it was placed in the machine, thus failing to receive such treatment as would bring out all its weak features. It was believed, however, that a satisfactory machine of the revolving drum type could be produced.

The design of a machine having a hexagonal drum with 3-ft. sides was begun and a few simple experiments made at the Forest Products Laboratory with a box and two platforms arranged to stand at an angle of 120 deg. with each other. This encouraged a belief that a good test could be developed with a hexagonal drum machine but showed that in order to test boxes of sizes up to that required for two dozen No. 3 cans, the sides of the drum should be not less than 3½ ft. and the inside length of the drum not less than 4 ft.

A drum of this size and form was built with its supporting frame and rotating mechanism and there then remained to be worked out the best arrangement of internal baffles or hazards and the proper speed of rotation. It had been conceived that the ideal arrangement would be that as the box passed from one side of the machine to another, it would follow a regular cycle of events including falls upon sides, top, bottom, ends, edges and corners and also flatwise upon a projection similar to the corner of another box, thus simulating, as far as possible, the different shocks and stresses to which a box is subjected in transportation, with the exception of the heavy static pressure received by a box from shocks to the car in coupling or in starting or stopping the train.

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[1] For a more detailed description of the box-testing machine referred to in this report, see "The Development of a Box-Testing Machine and Some Results of Tests," by J. A. Newlin and T. R. C. Wilson, *Proceedings*, Am. Soc. Test. Mats., Vol. XVI, Part II, p. 320 (1916).—ED.

Scantlings about 2 in. in thickness and 8 in. wide were bolted on the faces of the drums to form such hazards as was thought would produce the desired results. A pyramidal block was also applied to one face. The machine was then tried out by placing a box in it, observing the behavior of the box and noting the number of revolutions required to render it unserviceable. The boxes used in the tests were about 12 in. by 17 in. by 9 in. inside measurement and each contained two dozen No. 3 cans filled with water. The weight of this size box so filled is about 60 lb.

At first the box did not slide readily on the wooden hazards and on the maple flooring with which the drum was lined and boxes of different materials and different types did not slide with equal facilities. In order that all boxes may receive the same treatment it is essential that they make the same moves. Also as the machine rotated, the box would jump entirely over the hazards, which stood up only about 2 in. from the face of the drum and high baffle boards were installed to prevent this jumping. A reduction from the former speed of 4 r.p.m. facilitated the sliding of the boxes but further experiments demonstrated that a smoother lining was essential and a piece of No. 11 gage soft steel was placed on the face of each side. A piece of the siding had previously been taken out at each angle to permit the escape of splinters and other débris, and when the lining was installed the edge of each sheet was bent over so as to leave this space open. Scantlings having their edges lined with $\frac{3}{8}$-in. by $2\frac{1}{2}$-in. steel were also put in at such positions as previous experience had indicated was desirable. Experiments were then continued until the arrangement of hazards was finally determined. Exact records of performance kept together with observations of previous tests show that although all boxes do not pass through exactly the same cycle of events, yet the treatment received by any box during two or more revolutions is approximately the same as that received by any other box regardless of design or materials.

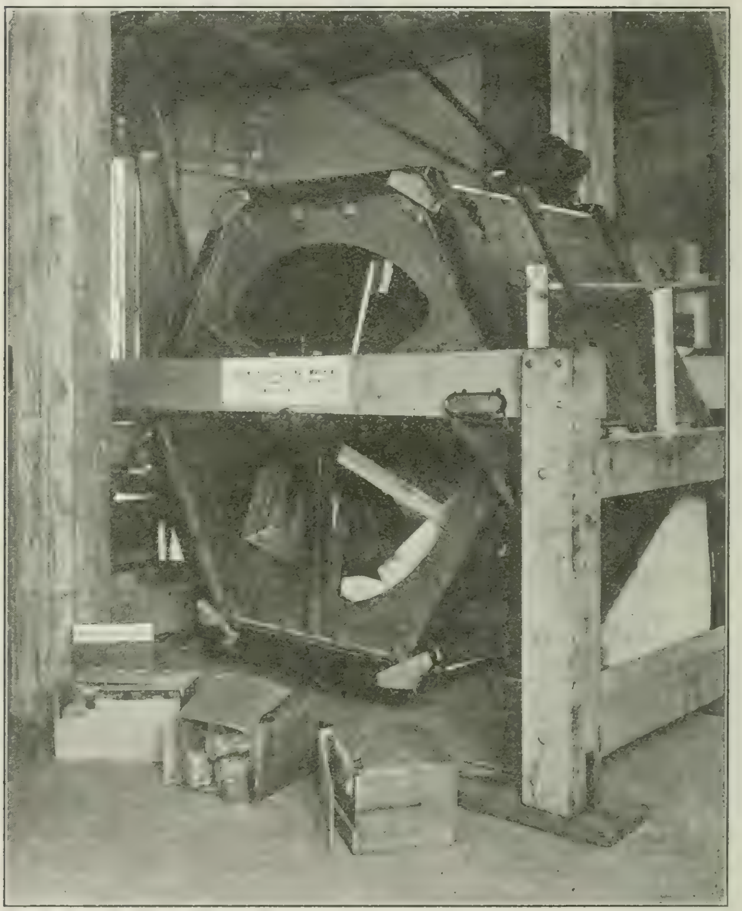

FIG. 1.—Box-Testing Machine.

As the machine now stands, it is capable of indicating the weaker points of any type or style of box. It is also believed that it can be used for a standard test to determine whether or not a box is capable of resisting a given amount of rough handling. It still remains to be decided how many revolutions of the machine give an amount of rough handling corresponding to what a box in service should be expected to resist. The machine will not measure the resistance to heavy pressure nor the ability of the box to protect its contents from pilferage or from damage by water or the like.

The swaying and jolting of a heavily loaded freight car is said to produce a nail-pulling or nail-loosening action on boxes carrying heavy goods in large shipments and it has been sughested that a box might be unable to resist this action and yet pass a good test in this testing machine. This we regard as very improbable as it has been observed in these tests that the nails sometimes begin to come loose at the first drop of the box. It has been found also that this trouble of nail loosening can be averted by the use of sufficient nails of a size and length properly adapted to the lumber used and this suggests that the loosening attributed to the motion of the cars is very probably due to the same cause and could be prevented by better nailing.

The tests made in developing the machine demonstrated that there is a wide variation in the resistance to rough handling shown by boxes of the same material and apparently only slightly different in design; that the resistance of some of the poorer boxes can be multiplied from ten to twenty times by simple and inexpensive changes and that the nailing and end construction are of more importance than the material of which the box is made.

Changes will probably be made in the testing machine from time to time and it is hoped that other machines and other tests may be developed but for the present the foregoing outline will give a general idea as to the results accomplished.

The work which has been carried on with the machine in connection with the desire to prepare specifications has so far been applied only to wooden boxes, as the specification under consideration was for wooden boxes to transport canned goods.

In connection with the tests and with the preparation of a definite specification, it was found necessary to divide the various kinds of woods into classes according to their strength and suitability for box making. The Forest Products Laboratory has a large amount of data relating to the strength of various kinds of woods and this, together with the assistance of men of extended experience in the box trade, enabled a tentative division to be made in a satisfactory manner, as follows:

GROUP NO. 1.

Alpine fir
Aspen
Balsam fir
Basswood
Buckeye
Butternut
Cedar
Chestnut
Cottonwood
Cucumber
Cypress
Magnolia
Noble fir
Redwood
Spruce
Sugar pine
Western yellow pine
White fir
White pine
Willow
Yellow poplar

GROUP NO. 2.

Douglass fir
Hemlock
Larch
Southern yellow pine

GROUP NO. 3.

Ash
Beech
Birch
Black gum
Elm
Hackberry
Hickory
Maple
Oak
Red gum
Sycamore
Tupelo

When necessary and advisable, variation in construction on account of variation in strength of material used in boxes will be based on this classification.

There is subjoined, for consideration with this report, a picture of the box-testing machine mentioned briefly herein as having been developed (Fig. 1). In order to demonstrate more clearly the operation of this machine, arrangement has been made for a short description and illustrative moving picture which will be presented at the end of this report.

This report has been submitted to letter ballot of the committee, which consists of 29 members, of whom 23 have voted affirmatively, 1 negatively, and 5 have refrained from voting.

Respectfully submitted on behalf of the committee,

B. W. DUNN,
Chairman.

REPORT OF COMMITTEE D-11

ON

RUBBER PRODUCTS.

During the past year Committee D-11 has held two meetings, in addition to meetings of the various sub-committees.

Sub-Committee I on Air Hose.—This sub-committee is at the time of writing this report without a chairman, owing to the resignation of the former chairman, Mr. E. B. Tilt, who has moved his residence to England. The work of this sub-committee has on that account been interfered with.

Sub-Committee II on Belting.—Various specifications have been considered by the sub-committee and considerable progress has been made in drafting specifications which should prove satisfactory for general use. At the present time the only matters still under discussion are the friction test and the tensile strength and elongation of the belt as a whole, and these problems are now in a fair way to be satisfactorily solved.

Sub-Committee III on Cold-Water Hose.—This sub-committee has prepared proposed Tentative Specifications for $2\frac{1}{2}$, 3 and $3\frac{1}{2}$-in. Double-Jacketed Cotton Rubber-Lined Fire Hose for Public Fire Department Use. These specifications are based upon those adopted by the Society last year for $2\frac{5}{8}$-in. Cotton Rubber-Lined Fire Hose for Private Department Use,[1] only such changes being made as were necessary on account of the difference in the character of the service and the size of the hose. The same rubber compound is specified in the rubber lining as required by the specifications adopted last year. These specifications were referred to the whole committee by letter ballot with the following results: Voted affirmatively, 14; negatively, 4; not voting, 7; no reply, 5. The proposed specifications are appended to this report,[2] and it is recommended that they be published by the Society as tentative.

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[1] 1915 Year-Book, p. 435.

[2] These specifications appear on pp. 487-491.—Ed.

Sub-Committee V on Insulated Wire.—Several meetings have been held by this sub-committee for the consideration of a number of matters which were still under discussion at the last annual meeting. All of these matters are now in a fair way to be satisfactorily settled, and it is expected that at the approaching annual meeting of the Society the committee will be in a position to recommend a set of tentative specifications for publication by the Society.

Sub-Committee VII on Steam Hose.—This sub-committee reports that it is advisable to await final action by the Master Car Builders' Association on their steam-heat hose specifications before giving the matter further consideration.

Two new sub-committees have been appointed during the year, as follows:

Sub-Committee VIII on Definitions and Nomenclature, Frederic Dannerth, *Chairman.*

Sub-Committee IX on Rubber Insulating Tape, J. M. Bierer, *Chairman.*

Sub-Committee VIII is to prepare definitions of terms used in specifications prepared by Committee D-11 and various other terms used in the rubber industry. Sub-Committee IX is to consider the preparation of specifications for rubber or rubber-coated insulating tape as used in electrical wiring work.

This report has been submitted to letter ballot of the committee, which consists of 30 members, of whom 20 have voted affirmatively, 1 negatively, and 9 have refrained from voting.

Respectfully submitted on behalf of the committee,

E. A. BARRIER,
Chairman.

F. M. WARING,
Secretary.

EDITORIAL NOTE.

The proposed Tentative Standard referred to in this report was amended at the annual meeting by the insertion of an explanatory note at the end. It was accepted for publication as amended, and appears on pages 487–491.

On the recommendation of the committee, the proposed Tentative Specifications for Insulated Wire and Cable: 30 per cent Hevea Rubber, as printed in the 1915 Proceedings, were accepted for publication, with certain amendments, among the Tentative Standards in the Proceedings. These are the specifications referred to in the report under the heading "Sub-Committee V on Insulated Wire," and appear on pages 492–517.

REPORT OF COMMITTEE D-13

ON

TEXTILE MATERIALS.

Since the last annual meeting of the Society, the committee has held two meetings, one in Washington, D. C., January 8, at which 14 members and 18 guests were present; the other in New York, March 17, at which 18 members and 12 guests were present.

A number of helpful investigations have been undertaken by members of the committee and the results of some of this work are appended to this report under the following titles:

Appendix I.—Method of Studying the Action of Specimens of Textile Fabric during Tests, by H. L. Scott.

Appendix II.—Comparison of Strip and Grab Methods of Testing Textile Fabric for Tensile Strength, by W. S. Lewis.

Appendix III.—Comparison of Strip and Grab Methods of Testing Textile Fabric for Tensile Strength, by E. D. Walen.

Appendix IV.—Determination of Tensile Strength of Duck by the Strip Method, by E. D. Walen.

Appendix V.—Effect of Unbroken Warp Threads on Tensile Strength of Textile Fabric, by John Lind.

The Tentative Tests for Automobile Tire Fabrics[1] submitted last year have developed interesting discussion and while as a whole they have proved quite satisfactory, it has seemed advisable to the committee to amend them in some minor details, rearrange the subject matter and continue them as tentative under the title "Tentative General Methods for Testing Cotton Fabrics." These methods, which are appended to this report,[2] are intended to be general in their application, and contain the following features not specified in the tests submitted last year:

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[1] 1915 Year-Book, p. 574.

[2] These Methods appear on pp. 572–578.—Ed.

1. Definition of "Dry Condition" and "Standard Condition" with respect to moisture;

2. Method for determining the thickness of the fabric; and

3. The sub-division of the determination of tensile strength into two alternate methods designated as "strip" and "grab" methods. The strip method is substantially the same as that published last year.

In preparing these methods the committee has had in mind especially automobile tire fabrics, hose and belting duck, and ordinary plain-weave cotton fabrics. Where material requires special treatment, it is the intention of the committee to describe specific methods and tests as they are developed, and such tests shall have precedence over the general methods. The committee has prepared tentative tests for two such materials, namely, automobile tire fabrics and hose and belting duck. These are entitled, respectively, Tentative Tests for Automobile Tire Fabrics and Tentative Tests for Fabrics for Use in Hose, Belting and Similar Articles, and are appended to this report.[1]

The committee recommends that the three tentative standards referred to above be published as tentative. The vote of the committee by letter ballot on this recommendation is as follows:

Tentative Standard.	Affirmative.	Negative.	Not Voting.
1. Method for Testing of Cotton Fabrics	18	2	8
2. Tests for Automobile Tire Fabrics	19	2	7
3. Tests for Fabrics for Use in Hose, Belting and Similar Articles	17	3	8

Some consideration has been directed to cement-bag materials, but on account of insufficient information the committee is unable to submit any specific recommendation. Such portions of the General Methods for Testing Cotton Fabrics as are applicable to cement-bag materials are recommended for use as tentative methods.

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[1] These Tests appear on pp. 531–533.—Ed.

This report has been submitted to letter ballot of the committee, which consists of 28 members, of whom 16 have voted affirmatively, 2 negatively, and 10 have refrained from voting.

Respectfully submitted on behalf of the committee,

W. D. HARTSHORNE,
Chairman.

D. E. DOUTY,
Acting Secretary.

EDITORIAL NOTE.

The three proposed Tentative Standards referred to in this report were accepted for publication and appear on pages 531–533 and 572–578.

The committee presented proposed Tentative Tests for Cotton Fabrics for Use in Bags and Bagging Material, which had not previously been submitted to letter ballot of the committee, as required by the Regulations Governing Standing Committees. These tests were accordingly accepted for publication provided a subsequent letter ballot of the committee on them should be carried without a dissenting vote. This ballot resulted in the affirmative without a dissenting vote, and the Tentative Standard therefore appears on pages 534–535.

For Discussion on the report, see page 386.

APPENDIX I.

METHOD OF STUDYING THE ACTION OF SPECIMENS OF TEXTILE FABRIC DURING TESTS.

By H. L. Scott.

The wide difference of opinion regarding the testing of fabrics is doubtless due in a large measure to the inaccuracy of the apparatus employed. Great variations are obtained from the same fabric tested on the same dynamometer when held by different means. It is therefore obvious that the more data submitted under these varying conditions, the wider the difference of opinion may be.

Textile fabrics, owing to their nature and lack of sharp outline, are difficult to reproduce by photographic means. Lantern slides, or motion pictures, when magnified and projected upon a screen, are too indefinite to illustrate the actual effect of stress upon the fabric. The value of motion photography for this work is greatly lessened by the fact that a film must be run at constant speed and a more deliberate study of the sample is impossible.

Henry L. Scott & Co., manufacturers of testing machines, conceived the idea of reproducing or projecting upon a screen, by means of an opaque projection lantern, a highly magnified view of a fabric sample during a test. With the cooperation of the Bausch and Lomb Optical Co., the apparatus shown in Fig. 1 was constructed and exhibited before Committee D-13 of the Society in the office of the U. S. Rubber Co. of New York City on March 17.

Parts of a standard horizontal tire-fabric tester were mounted upon a temporary oak base so constructed as to also support a balopticon lantern. No recording head was used. The fixed clamp was held rigidly in a horizontal position on a solid iron frame attached to the base. The moving clamp was attached to a draw bar, or stretching screw, operating through a gear box holding the driving mechanism. Hand wheels on either side of the gear box were used to transmit power to the stretching screw and were so geared as to give any speed desired. The hand wheels at each end of the machine permitted changing clamps quickly. Knurled adjustment collars, movable upon the thread of the stretching screw, assured the return of the moving clamp to the same position for each sample.

In addition to the flat-grip clamps shown in Fig. 1, other devices were used, and by means of interchangeable anvils or gripping surfaces several methods of testing were illustrated. A device was also arranged for working two knives underneath the sample to cut the fabric in such manner as to produce the "gash" test.

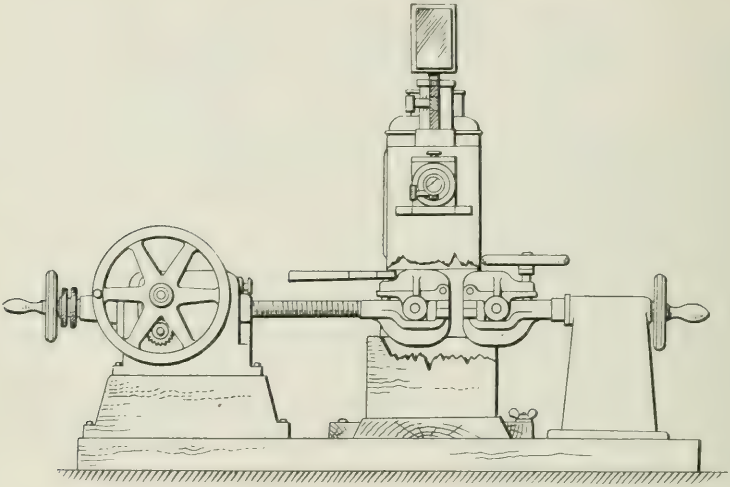


FIG. 1.—Apparatus for Visualizing Fabric Breaking.

The apparatus was installed in a darkened room and the projection made upon a special aluminum screen at a distance of approximately 20 ft. As nearly all tests were made on tire fabric, having 23 ends per inch, each end thus projected was about 1 in. in diameter. Samples were broken in a bone-dry, normal and saturated condition to note the effect of moisture.

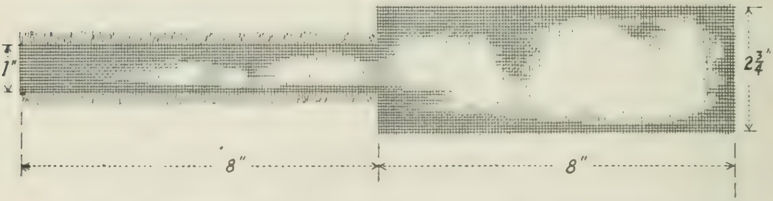
Tests showing the effect of varying speeds of the moving clamp were also made. Elongation, number of threads broken, effect of tension, slip in the clamps and comparative values of different methods were readily observed. Since innumerable tests could be made and any test repeated, and the speed regulated or the stretching motion stopped for any length of time desired, many interesting points were brought out.

APPENDIX II.

COMPARISON OF STRIP AND GRAB METHODS OF TESTING TEXTILE FABRIC FOR TENSILE STRENGTH.

By W. S. Lewis.

The determination of the tensile strength of fabric is usually the most important test that can be applied to ascertain the quality. This test is also very useful in determining the comparative value of two or more fabrics. For these reasons many methods have been advocated and employed for ascertaining this property of textile fabrics; it is probable, however, ninety per cent of the tests are made by one of two common methods, namely, the "strip method" and the "grab method." These two methods will be discussed in this paper.



(*a*) Strip Test. (*b*) Grab Test.

Fig. 1.—Test Specimens.

During the past two years many disputes have arisen where the strip method was employed by one party and the grab method by the other party to the controversy. The Bureau of Standards has received many inquiries concerning these methods, especially requesting a statement as to the relation of the results of determinations of tensile strength obtained by both methods.

With the view of definitely ascertaining certain facts concerning the methods, several series of comparative tests were made upon various kinds and weights of fabric. The same testing machine was employed for all tests, the same yarns were clamped in the jaws in the two methods of test, and the atmospheric conditions were identical so that the results are felt to be comparable.

Test specimens from the same yarns were prepared as illustrated in Fig. 1. The strip-test specimens, Fig. 1 (*a*), were prepared by cutting pieces of fabric 8 in. long by slightly more than 1 in. wide, and then pulling out yarns from both sides until a 1-in. width was obtained. The grab-test specimens, Fig. 1 (*b*), were pieces of fabric cut 8 in. long by $2\frac{3}{4}$ in. wide.

TABLE I.—TENSILE STRENGTHS OF WOOL AND COTTON FABRICS.

WOOL FABRICS.

Kind of Fabric.	Strip Method (1-in. strip), lb.	Grab Method (1-in. grab), lb.	Percentage Increase of Grab Method over Strip Method.
Shirting	15.0	26.6	77
Bunting	27.6	31.2	13
Serge	24.5	45.3	85
Kersey	29.0	57.0	97
Bunting	31.5	38.5	22
Shirting	33.7	49.5	47
Bunting	35.3	40.6	15
Bunting	34.6	39.6	14
Kersey	35.5	65.2	84
Blue Melton	34.5	72.0	109
Overcoating	36.8	66.3	80
Press Felt	38.2	82.0	115
Blue Melton	37.0	78.3	112
Gray Melton	48.2	75.0	56
Serge	52.5	80.8	54
Overcoating	58.0	100.5	73
Press Felt	77.0	124.0	61
COTTON FABRICS.			
Crepe	9.2	10.4	13
Muslin	15.0	15.0	0
Bleached Muslin	16.4	17.8	9
Voile	15.5	16.9	9
Crepe	17.1	21.6	26
Voile	15.5	19.5	26
Voile	17.6	18.6	6
Flannel	23.5	27.5	17
Lining	30.9	32.3	5
Madras	41.5	44.5	7
Madras	29.6	38.2	29
Bleached Sheeting	38.3	46.7	22
Sheeting	39.5	54.5	38
Lining	46.4	57.0	23
Unbleached Muslin	43.3	54.8	27
Unbleached Muslin	42.3	48.5	15
Unbleached Muslin	40.7	51.8	27
Sheeting	45.0	52.5	17
Gingham	45.2	56.5	25
Osnaburg	55.5	69.0	24
Duck	223.0	275.0	23

In the strip tests the 1-in. width of the piece was clamped in the jaws of the testing machine in the usual way. In the grab tests, two methods were used: first, the test specimens were clamped at both ends in jaws 1 in. wide; second, the test specimens were clamped at one end in jaws 2 in. wide and at the other end in jaws 1 in. wide. The testing length between jaws in all tests was 3 in.

TABLE II.—TENSILE STRENGTHS OF WOOL AND COTTON FABRICS.

WOOL FABRICS.

Kind of Fabric.	Strip Method (1-in. strip), lb.	Grab Method (2 and 1-in. grab), lb.	Percentage Increase of Grab Method over Strip Method.
Kersey	25.0	47.5	90
Serge	26.0	29.0	12
Kersey	28.0	54.0	93
Kersey (F)	30.5	64.0	110
Kersey (W)	31.0	60.0	94
Bunting	31.0	39.5	28
Kersey	32.5	68.5	111
Kersey	35.5	63.5	79
Melton	37.0	75.0	103
Felt (F)	38.5	87.5	127
Kersey	39.5	79.0	100
Melton	42.0	87.5	108
Serge	48.0	48.0	0
Kersey	50.0	93.0	86
Felt (W)	72.7	151.7	109
COTTON FABRICS.			
Muslin	15.0	16.0	7
Flannel	24.5	34.0	38
Sheeting	34.0	47.5	40
Muslin	44.5	59.5	34
Toweling	47.0	54.5	16
Osnaburg	48.0	66.5	38
Sheeting	54.0	76.5	42
Damask	66.0	99.0	50
Osnaburg (W)	66.0	78.0	18
Sheeting	70.5	89.5	27
Ticking	71.5	96.0	34
Awning	73.5	98.0	33
Osnaburg (F)	82.0	101.0	23
Duck	224.0	304.0	36

(W) = Warp.
(F) = Filling.

The results of the tests are given in Tables I and II. Each value is the average of either three or five tests. The results of the grab test using two 1-in. jaws are given in Table I, while the results obtained by using one 2-in. and one 1-in. jaw are given in Table II.

From an examination of the tables it will be observed that no general relation for all fabrics exists between the results of tests obtained by the strip and grab methods. The difference between the results of tests of the two methods in the cotton fabrics are caused chiefly by the character of the weave, number of yarns per inch, and elongation of the yarns under stress. With the wool fabrics, however, in addition to the influence of various weaves, constructions, and elongations, the degree of felting plays a very prominent part in the resulting tensile strength in the grab method of test.

APPENDIX III.

COMPARISON OF STRIP AND GRAB METHODS OF TESTING TEXTILE FABRIC FOR TENSILE STRENGTH.

By E. D. Walen.

In the determination of tensile strength of tire fabric, various types of test specimens have been suggested, of which at present there are two in common use, referred to as the strip method and the 2-in. and 1-in. grab method.

Strip Method.

The strip method consists of cutting strips 1½ in. wide by 8 in. long, and ravelling them from 1½ in. to 1 in. in width, thus leaving a fringe of ¼ in. on each side.[1] The specimen thus prepared is placed in the tensile strength machine, 3 in. between jaws, and the stress at the breaking load recorded.

The appearance of the sample at the time just before rupture is shown in Fig. 1, in which *a* and *b* represent yarns which have become disengaged from the yarns running at right angles to them and consequently have been made straight. These yarns do not break until after the body of the sample *c* has broken, and apparently do not carry their proportionate amount of the stress as measured by the testing machine. Inasmuch as the external appearance of the sample does not give an adequate conception of the magnitude of the stresses carried by the yarns, it was thought advisable to determine the relative amount of stress carried by the yarns which are straightened and do not break.

If specimens of various widths are broken, their strength is either directly proportional to the number of threads, or is made either more or less by the difference in position between the extreme outside threads and the inside threads.

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[1] See Appendix II to Report of Committee D-13, Fig. 1 (page 366), for an illustration of this specimen.—Ed.

In considering the first assumption, the equation of a curve obtained from plotting tensile strength against the corresponding number of threads in the sample would be:

$$y = bx$$

where y = the tensile strength of the specimen; x = the number of threads; and b = the slope of the curve.

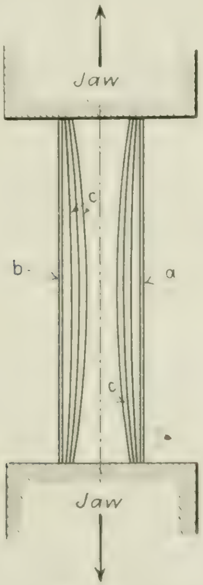


FIG. 1.—Strip-Test Specimen before Breaking.

An average single-thread "break" at any point may be obtained by dividing the tensile strength y by the corresponding number of threads x; and the equation of the curve obtained by plotting average single-thread breaks against the corresponding number of threads would be:

$$y_1 = b,$$

where y_1 = the average single-thread strength. This curve would be a straight line with a zero slope and therefore parallel to the X-axis.

If the outside threads did not carry the same average stress as the inside threads,—assuming the same elongation and same number of straightened threads for samples of different widths,—the curve obtained by plotting the tensile strength against the corresponding number of yarns in the sample would be:

$$y = \pm a + bx$$

where y = the tensile strength of the specimen; b = the slope of the curve; x = the number of threads; and a = a constant depending upon the difference in stress carried by outside and inside threads.

The average single-thread break would be represented by the equation:

$$y_1 = \pm \frac{a}{x} + b$$

where y_1 = the average single-thread strength. The slope of this equation would be $\pm \frac{a}{x^2}$, and the curve would not be parallel to the X-axis.

Warp strips varying in width of from 5 to 45 threads and 8 in. long were prepared from $17\frac{1}{4}$-oz., 23-threads square, tire fabric and allowed to remain in an atmosphere of 65-per-cent relative humidity and a temperature of 70° F. (21° C.) for a period of three hours. It has been found by experiment that the moisture condition of the fabric is approximately in equilibrium with that of the atmosphere at the end of this time. The samples were placed in a testing machine, 3 in. between jaws, broken at a speed of the pulling jaw of approximately 12 in. per minute, and the breaking stress obtained. The results of the tests are given in Tables I, II and III.

Curve *B* (Fig. 2) was obtained by plotting the tensile strength against the corresponding number of threads. The average single-thread strength is represented by curve *E*. It may readily be seen that the tensile strength is directly proportional to the number of threads, and that the average single-thread strength is the same regardless of the width of sample tested; hence, the outside threads carry their proportional part of the apparent stress as measured by the testing machine.

It will be noted that beyond 35 threads, curve *B* falls. This

TABLE I.—STRENGTH OF SINGLE STRAND OF YARN.

(USED FOR PLOTTING CURVE *A*, FIG. 2).

KG.	KG.	KG.
6.5	6.4	6.7
6.2	6.9	6.6
6.7	6.6	6.8
6.7	7.1	7.3
7.1	6.5	6.5

Average Value .... 6.7 kg.

TABLE II.—TENSILE STRENGTH OF FABRIC BY STRIP METHOD—VALUES IN KILOGRAMS.

(PLOTTED IN CURVE *B*, FIG. 2).

	Number of Threads in Strip.								
	5	10	15	20	25	30	35	40	45
	28.0	58.0	87.8	105.0	147.5	168.0	197	232	206
	28.2	59.4	83.0	105.2	141.8	149.3	198	243	260
	28.0	59.0	84.0	103.0	141.2	170.4	204	216	226
					140.8	165.0	210	223	236
Average.	28.1	58.8	84.9	104.4	142.8	163.2	202	228	232

TABLE III.—TENSILE STRENGTH OF FABRIC BY GRAB METHOD—VALUES IN KILOGRAMS.

(PLOTTED IN CURVE *C*, FIG. 2).

	Number of Threads Gripped by Lower Jaw.						
	6	12	17	23	29	40	46
	78	120	155	175	207	215	245
	82	119	142	173	190	230	246
	80	117	165	173	197	214	238
		112	156	176	195	232	233
Average	80	117	154.5	174.5	197.2	222.7	240.5

is due to the difficulty of placing the sample in the jaws in such a way as to obtain a break without tearing. Several good breaks were obtained and these results would warrant extending the curve.

In order to further ascertain the amount of stress carried by the outside threads, elongation measurements were made on specimens of various widths, and the total stretch at the breaking load was found to be sensibly the same for all widths. Single strands were then subjected to a stress sufficient to produce the elongation at the breaking load of the specimen, and it was found that they carried practically the same stress as the average single-thread break calculated from curve *B*. It was also observed that the same number of outside threads failed to break in samples of various widths.

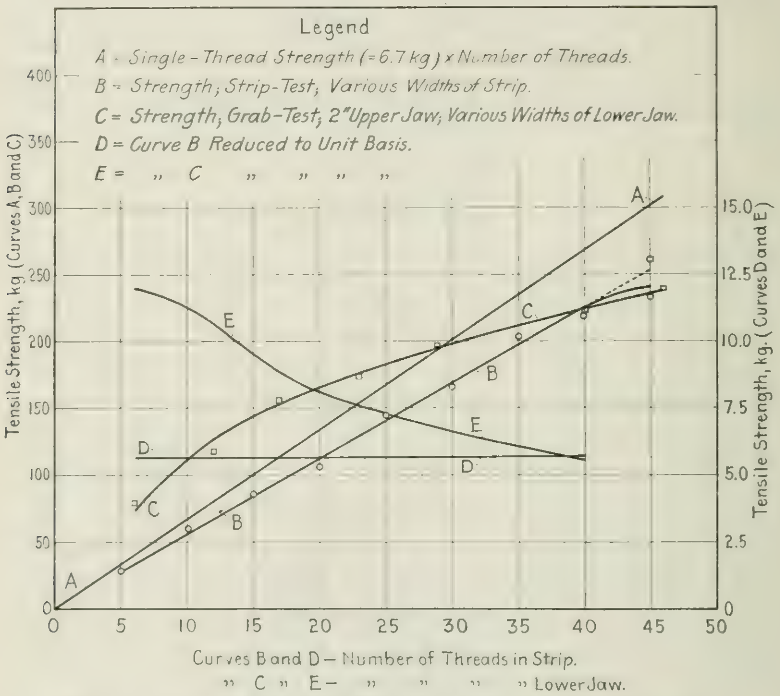
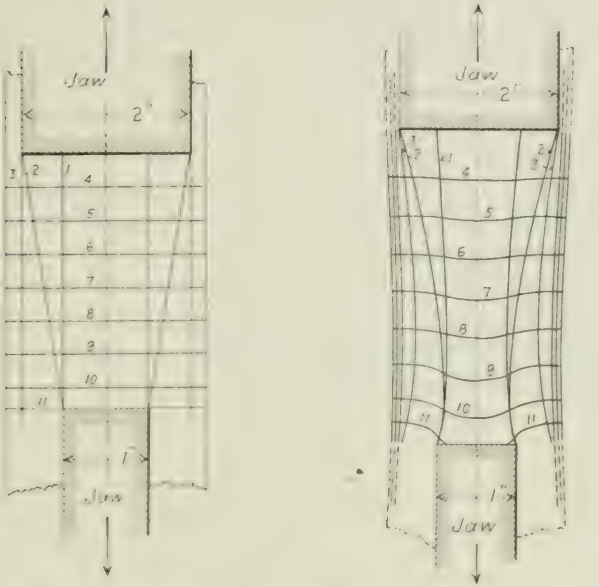


FIG. 2.—Strength Curves of Fabric by Strip and Grab Methods.

Curve *A* was obtained by multiplying the average single-strand yarn strength (6.7 kg. in these tests), found by breaking single yarns, by a number corresponding to the number of threads in the strips. If the strip method were a single-strand test, curve *B* would coincide with curve *A*.

In the case of the filling it was found that the corresponding curve *B* was much closer to the corresponding curve *A* than in the case of the warp.



(*a*) Before Testing. (*b*) Just before Breaking.

FIG. 3.—Grab-Test Specimen.

GRAB METHOD.

The sample for the 2-in. by 1-in. grab method was 2½ in. wide and 8 in. long. It was clamped in the machine with a 2-in. upper jaw and a 1-in. lower jaw, with 3 in. between jaws, as shown in Fig. 3.

Practically the same procedure was followed as in applying the strip method to the same fabric. The sample was cut 2⅜ in. wide and 8 in. long. The top jaw was kept a constant width of 2 in. and varying widths of the bottom jaw were used gripping from 6 to 46 yarns. The width between jaws was 3 in. The result obtained from plotting the tensile strength against the corresponding number of threads gripped by the bottom jaw is shown by curve *C*, Fig. 2.

An average single-thread strength is obtained by dividing the tensile strength of the fabric by the number of yarns gripped by the bottom jaw, and is represented by curve *D*.

It may readily be seen that the observed relative strength of the fabric is affected by the width of lower jaw, and there is no logical reason for selecting any point on the curve *C* as representing the true strength of the fabric.

The pronounced hump in curve *C* is due to the varying amount of stress carried by the strands not in direct tension. This is indicated in Figs. 3 (*a*) and (*b*). Lines were drawn on the sample before it was put in the jaws, as shown in Fig. 3 (*a*). The distortion of these lines at a time just before the break, as indicated in Fig. 3 (*b*), shows very clearly that the stress carried by the yarns not in direct tension is an important one, and that the deformation is not such as would be expected to approximate practical conditions.

NOTE CONTRIBUTED BY

W. D. HARTSHORNE.

(CHAIRMAN, COMMITTEE D-13.)

Attention is called to the fact that Mr. Walen, in constructing curve *C*, intended simply to illustrate that in testing the ordinary 23 by 23 tire fabric there was a *variable* proportionate effect by the grab method of test when using various widths of the narrow jaw, as contrasted with the *constant* proportionate effect by the strip method on the same fabric when grasping a variable number of threads; and that this relationship could only be claimed for the particular fabric and the particular conditions under which it was tested. In this connection note especially his paper on the strip method as applied to duck materials.[1]

But attention is called to the fact that if this line (curve *C*) had been constructed on the basis of using for the values of x the actual widths of jaw, rather than the approximate number of ends clamped, the first three points corresponding to $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$-in. jaws could have been considered as lying on a straight line, which when prolonged back to the Y-axis cuts it at the point $y=43$ and represents a line slightly inclined to curve *A*. Assuming the number of threads grasped as strictly in proportion to the width of the jaw, the following relationships may be noted:

Width of Lower Jaw, in. (x).	Number of Threads.	Figured Strength, kg.	Average Strength Actually Found, kg.
$\frac{1}{4}$	$5\frac{3}{4}$	37 +43 = 80	80
$\frac{2}{4}$	$11\frac{1}{2}$	(2×37 = 74) + 43 = 117	117
$\frac{3}{4}$	$17\frac{1}{4}$	(3×37 = 111) + 43 = 154	154.5
$\frac{4}{4}$	23	(4×37 = 148) + 43 = 191	174.5
$\frac{5}{4}$	$28\frac{3}{4}$	(5×37 = 185) + 43 = 228	197.2
$\frac{6}{4}$	$34\frac{1}{2}$	(6×37 = 222) + 43 = 265	(?)
$\frac{7}{4}$	$40\frac{1}{4}$	(7×37 = 259) + 43 = 302	223 + (?)
$\frac{8}{4}$	46	(8×37 = 296) + 43 = 339	240 + (?)

The equation of the curve which would be obtained by plotting the figured strengths in the above table is given in equation (1), determined as follows:

The value 37 is the increase in strength for each $5\frac{3}{4}$ threads, therefore the slope $= 37 \div 5\frac{3}{4} = 6.43$. Expressing this in terms of the slope of curve *A* ($=6.7$, the average single-thread strength), $6.43 = 0.96 \times 6.7$. If the curve be prolonged *backward* to its intersection with the X-axis, the number of threads corresponding to the ordinate 43 is $\frac{43}{37} \times 5\frac{3}{4} = 6.67$ and $6.67 = 0.29 \times 23$; that is, 6.67 is theoretically the number of threads gripped by a 0.29-in. jaw. Evidently, the equation of the curve may now be written as follows:

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[1] Appendix IV to Report of Committee D-13, p. 379.—ED.

$$y=0.96\times 6.7\ (x+0.29)\ 23=6.43\times 23\ (x+0.29)\ldots\ldots(1)$$

in which x = the width of the jaw in inches. Equation (1) fits the test results up to the $\frac{3}{4}$-in. jaw.

In the case of the strip method, using the same notation, the equation is

$$y=0.84\times 6.7\ (23x)=5.62\ (23x)\ \ldots\ldots\ldots\ldots(2)$$

the value 5.62 (=0.84×6.7) being the slope of curve *B* or the ordinate to curve *D*. Equations (1) and (2) of course apply only to the 23 by 23 fabric under consideration.

This analysis suggests the nature of the supporting effect; how it is probably affected by the actual width of the piece of fabric used, and the angular relationship of the ends of the two sets of jaws.

For fabrics in general there is doubtless an important relation between crimp, number of threads per inch in both warp and filling, and the relative twist.

The Bureau of Standards is now having constructed special apparatus by which, as stated by Dr. Stratton under date of May 12, 1916: "It is hoped to correlate the four variables characteristic of the grab method of testing fabrics; namely, (1) width of jaws, (2) depth of jaws, (3) width of fabric, and (4) distance between jaws." Dr. Stratton further states that: "Results will be obtained as soon as possible and will be a continuation of the work of which Mr. Walen's paper was a preliminary report."

APPENDIX IV.

DETERMINATION OF TENSILE STRENGTH OF DUCK BY THE STRIP METHOD.

By E. D. Walen.

It has already been observed that the strength of a strip of tire fabric is directly proportional to the number of threads in the strip. The peculiar distribution of crimp in the warp and filling of a duck, however, suggests that a condition might exist different from that existing in more regularly constructed fabrics.

Samples of duck were tested using the strip method in the same manner as tire fabrics. The results shown graphically in Fig. 1, which were obtained from tests made upon No. 1 bag duck weighing approximately 28 oz. per sq. yd., are typical for ducks having a marked difference between the crimp in warp and that of the filling.

Tests of Warp Strips.—It was observed that the ultimate elongation and number of threads which do not break was practically the same for all widths of strips tested.

Curve A was obtained by plotting the tensile strengths of the warp as ordinates and the corresponding number of threads in the strips as abscissas. It will be noted that the curve shows a negative strength for zero number of threads, equal in amount to the ordinate F. The equation of curve A is in the form:

$$y = bx - a,$$

where the value of a equals the ordinate F.

The average single-thread break, obtained by dividing the tensile strength by the number of threads in the strip, is represented by curve E.

From these curves it can readily be seen that the strength of the warp strips is not directly proportional to the number of threads and that the unbroken threads do not carry their proportionate part of the stress applied. The value corresponding to the ordinate *F* may be added to each value of tensile

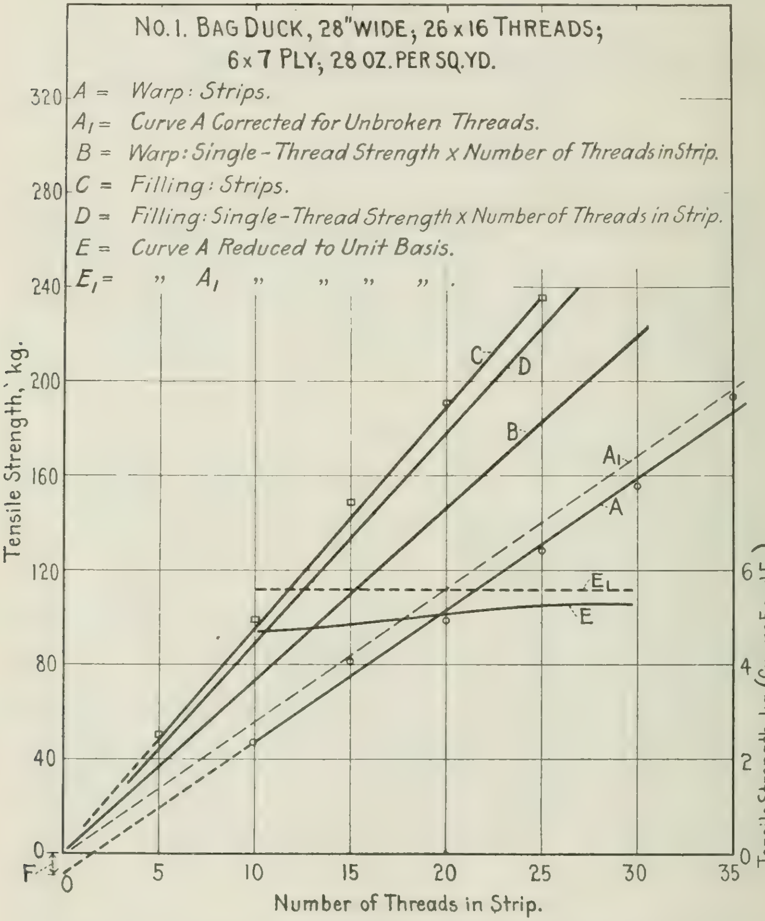

FIG. 1.—Strength Curves of Duck Fabric by the Strip Method.

strength as a correction factor, giving to the outside threads the same proportionate part of the tensile strength as carried by the inside threads. When the correction *F* is applied to curves *A* and *E*, curves A_1 and E_1, respectively, are obtained.

It might appear that a proper correction factor would be obtained by testing the unbroken threads and adding the value obtained to the indicated strength. Inasmuch as the yarn in its straightened condition after testing is capable of carrying more of the indicated stress than when it is distorted, the value obtained from the curves is a closer approximation to the correct one.

Another method for determining the value F suggests itself, but it is believed to be more or less uncertain. The number of unbroken threads is noted and it is assumed that all are under the same condition of stress. Yarns similar to those tested are subjected to a load sufficient to produce an elongation equal to the ultimate elongation observed in the strip specimen. The amount of this load is assumed to be equal to that carried by each of the unbroken threads of the strip specimen, at the time of rupture, so that the load multiplied by the number of such threads gives a correction factor to be added to the indicated strength of each strip.

Stress values were obtained by multiplying the average single-strand strength of the warp (found by breaking single strands) by numbers corresponding to the number of threads in the strips, and are plotted in curve B.

It will be noted that curve A_1 is lower than curve B. This is due to the fact that the interlacing of the warp threads over and under the filling threads diminishes the apparent strength of the individual threads by inducing forces during testing which are not parallel to the line of application of the load.

Tests of Filling Strips.—Curve C was obtained by plotting the tensile strengths of filling strips as ordinates and the corresponding number of threads as abscissas. From this curve it may be observed that the tensile strength of a filling strip is directly proportional to the number of threads. Curve D was obtained from the average single-strand strength of filling threads in the same way as curve B for the warp.

It will be noted that curve C is higher than curve D. This might reasonably be expected, as the filling threads are practically straight and their strength is increased by the binding action of the warp threads. This condition is the reverse of that observed in the warp.

SUMMARY.

In some fabrics the tensile strength of the strip is not directly proportional to the number of threads in the strip.

When the strength is not directly proportional to the number of threads, convenient and constant correction factors are obtainable as suggested above.

The strength as determined by the strip method is affected by the method of interlacing.

APPENDIX V.

EFFECT OF UNBROKEN WARP THREADS ON TENSILE STRENGTH OF TEXTILE FABRIC.

BY JOHN LIND.

At the meeting of Committee D-13 on March 16 and 17, 1916, some test specimens were shown on which the filling threads were tied together to keep the warp threads in place, and the results obtained with this form of test specimen proved that the unbroken warp threads do reduce the strength of a full inch of test specimen. The Bureau of Standards, through Mr. Walen, corroborated the results, and it was agreed to conduct further tests to find a way to correct for unbroken warp threads.

With this end in view, 10 test specimens, each of 5, 10, 15, 20, 25, 30, 35, 40 and 45 threads, were prepared under the direction of the writer and, also, a set of 3 test specimens each of the above number of threads, in which all the filling threads were tied together for a distance of 4 in. along each edge of the test specimen. All the test specimens were pulled 3 in. between jaws at a rate of 9 in. per minute under an atmospheric condition of 45 per cent humidity and a temperature of 70° F.

The average values of each set of tests have been plotted in Fig. 1. Curve *A* represents the strength-thread relation on the test specimens which were provided with a $\frac{1}{4}$-in. fringe of filling threads. It will be noted that the points at 20 to 45 threads fall on or very near the line. The points on this curve below 20 threads do not represent strength values of the fabric. At 5 threads the filling does not hold the warp threads during pulling in their kinked form, as a result of which the test actually indicates the strength of 5 *straight* threads. At 10 threads an average of 1.7 threads did not break, the general character of the test specimen during pulling being the same as for 5 threads, that is, nearly all the threads lost their kinked form, resulting in a test on straight threads. At 15 threads the fabric nature of the test pieces begins to assert itself, and as a result, an average of 6.4 threads did not break. The non-breaking of these threads resulted in a lower strength for 15-thread test specimens than for 10-thread specimens. At 20 threads and above, from 8 to 9.8 threads did not break, with an average of 9.25 threads.

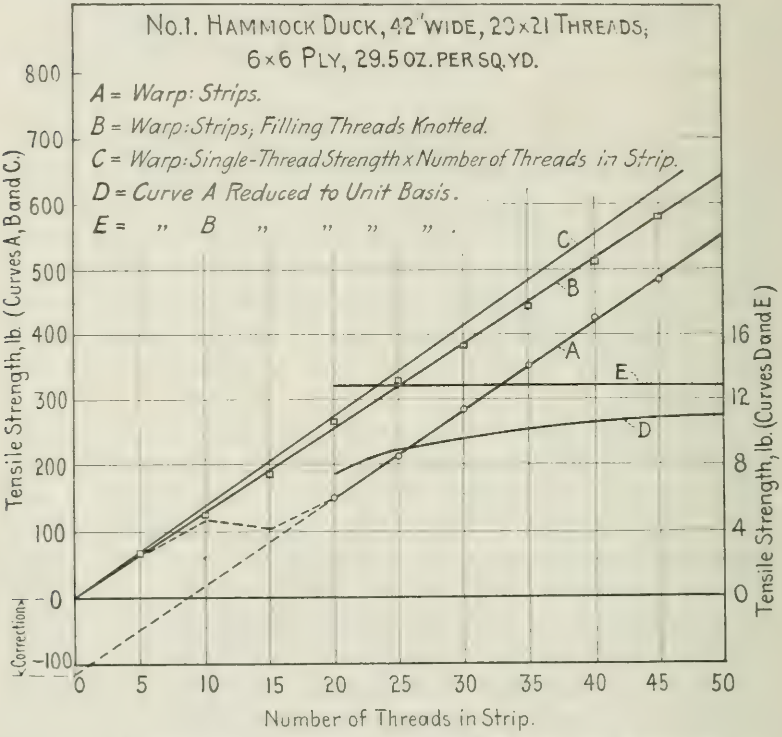

FIG. 1.—Strength Curves of Hammock Duck, Showing Effect of Unbroken Warp Threads.

Curve *A*, when extended backward to the axis of ordinates, gives a negative value of 111 lb. This value, as has been quite correctly pointed out by Mr. E. D. Walen, is the amount to be added to the breaking strength to obtain the true strength of a full-width test specimen. The strength values obtained with the test specimens with knotted filling threads plotted along curve *B* prove Mr. Walen's statement. In these knotted test specimens all the warp threads broke together, giving the strength of a full-width test specimen. Curve *B* theoretically is parallel to curve *A* and passes through the axis of coordinates. The closeness of curve *B* to parallelism with curve *A* is experimental proof of the "correction" determined by Mr. Walen.[1] This correction amounts to 111 lb. on the No. 1 Hammock Duck which the writer tested.

The results of these experiments enable us to calculate the true strength of a full-inch strip test specimen which, up to the present time, has been a problematical figure unless knotted test specimens are made. The cost of preparing this type of test specimen precludes its use except for research work.

The writer also investigated the stress on the unbroken threads by measuring the stretch of the test specimen at rupture. The stretch of these threads was found to be $\frac{3}{4}$ in. based on 3 in. between marks, and that when ravelled from the fabric after marking a distance of 3 in. the threads can be lengthened $\frac{3}{4}$ in. by simply stretching to remove the kink. This proves that the unbroken threads do not assume any stress up to the point of rupture.

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[1] This reference is to the ordinate *F* in Fig. 1 of Appendix IV, p. 380.—ED.

DISCUSSION.

Mr. Young.

Mr. C. D. Young.—I think it is most unfortunate that in offering these tentative methods and tests, the committee has proposed two methods of making physical tests of the fabrics, namely, the strip and grab methods. We have used both methods in the laboratory of the Pennsylvania Railroad Co., and we greatly prefer the grab method, considering the speed of operation and uniformity in results. We think that the strip method is a refinement unnecessary for fabric testing, and we hope that after the committee has had a year or more of experience with the two methods, they will be able to recommend to the Society one method of physical testing of cotton fabrics for adoption as standard.

I believe that the inconsistency of offering automobile fabrics to be tested by the strip method, hose and belting fabrics by the grab method, and bag material by both or either, is apparent. It seems to me that the committee is leaving the matter entirely too open. I feel that it would be much better to have one method, even though not quite so satisfactory to all.

I believe if the committee would communicate with the different testing laboratories and the consumers and find out what they would prefer from an operating standpoint, it would obtain valuable data. I believe the Bureau of Standards has established the fact that the strip method is the more accurate. Whether that method is better adapted in the laboratory to making the number of tests required, is of as much importance as its value in research work.

Mr. Hartshorne.

Mr. W. D. Hartshorne (*Chairman of Committee D-13*).—I think the committee as a whole will fully agree with Mr. Young, but it has become a necessity, in order to establish anything, to give full swing to people's ideas and gradually eliminate differences. It should be borne in mind that the grab test, while it has a number of advocates, has also to meet a very considerable opposition on the part of some of the government officials in the various departments. In considering different fabrics, such a variety of factors enter into the problem, whether it is the grab method or the strip method that is being considered, that the committee much prefers to leave the methods and tests stand as tentative for a further period until some of these controversies can be eliminated. **Mr. Hartshorne.**

Mr. Harvey. MR. DEAN HARVEY.—The proposed General Methods for Testing Cotton Fabrics specify that the length of the test specimen shall be 3 in. between jaws for the strip test and 1 in. for the grab test. Our experience has been that a short length between the jaws increases the tendency of the cloth to tear, due to any slight variation in the alignment of the jaws. I should like to inquire whether the committee has noticed a greater tendency for the cloth to tear with a short length between the jaws than a longer length of, perhaps, 6 in. While the 3-in. length may be sufficient for the strip test, it would seem that the 1-in. length might be rather short for the grab test.

The methods further specify that the thickness shall be measured by an automatic micrometer, but do not specify the pressure to be applied. I would suggest that the pressure be specified.

I should also like to ask whether there would be any advantage in suggesting a form of jaw which would give good results for gripping textile fabrics—not as a requirement, but simply as a suggestion.

Mr. Somerville. MR. A. A. SOMERVILLE.—It has been our experience that the distance of 1 in. between the jaws in the grab test gives the most uniform results when breaking consecutive strips, and it is for that reason that this distance is specified.

Mr. Young. MR. YOUNG.—In regard to the question of jaws and micrometer for the grab method, I would suggest that since the committee has not offered anything, it should give consideration during the coming year to the jaws and micrometer for textile fabrics and rubber adopted by the Master Car Builders' Association. The specifications of that association include requirements for the size of the shoe of the micrometer, and for the spring tension. A uniform standard in these matters would assist laboratories which already have proper facilities for doing that work. I might add, incidentally, that the Master Car Builders' Association specify the grab method, with 1 in. between the jaws of the grips.

Mr. Capp. MR. J. A. CAPP (*by letter*).—The General Electric Co. have always encountered considerable difficulty in testing textile fabrics, paper, etc., owing to the fact that it is not always easy to apply stress uniformly over the width of the test strip. In consequence of uneven distribution of load, fabrics will often tear rather than break evenly, and frequently the fabric is torn right at the edge of the jaw, which leaves the accuracy of the results in doubt.

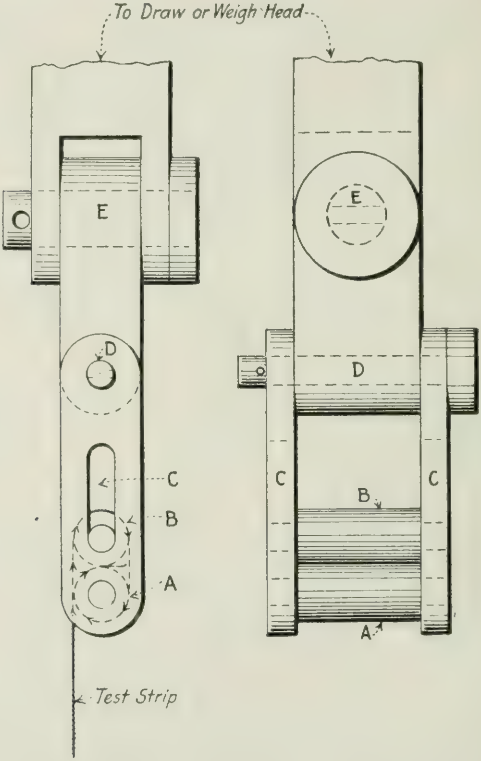

FIG. 1.—Grips and Shackles for Textile Tests.

Some years ago, when working on grips for determining the tensile strength of rubber, a special form of gripping device was worked out and it has proved so acceptable that its use in the laboratory with which the writer is associated has generally been extended to the testing of textiles, paper and even twine. The grips and shackles used are shown in Fig. 1. The gripping device consists of a pair of straps, at the lower end of

Mr. Capp. which is a fixed pin A, which straps are suspended from the pin D by a tongue which is itself suspended from a pin E. Pin E is carried by a strip which is attached to the draw head or weigh head of the machine, as the case may be. By this means the straps carrying the pin A are allowed to swing in two directions at right angles, and the effect of a universal joint is given. Axial loading is therefore secured.

Immediately above pin A is a roller B, which is free to move in the slots C. The test strip is place over the roller B, down, beneath and around pin A, and the end of the test strip is then inserted between the roller B and the pin A, reasonable care being taken to see that the test strip is placed evenly on the roller and pin. When stress is applied to the test strip, the roller B is pressed tightly against the end of the strip between the roller and the pin A, and the harder the pull the tighter the grip. The arrows in the sketch indicate the direction taken by the test strip when being placed in the grips.

We have used this pin and roller grip for a number of years, and it is very rare that we fail to obtain a fair break which usually occurs between the two sets of grips. As has already been stated, the method is applicable not only to textile fabrics but also to rubber products and even to twine or light cordage. In the case of harder cordage of considerable diameter, we place the end of the cord twice around the pin A so that the roller B will bear on two pieces of the cord, and will therefore lie substantially parallel to pin A. These grips have been used for testing fine wires which are very difficult to hold with any other form of grip with which we have had experience. If the ordinary type of wedge grip is used, the wire is nearly always cut or injured at the end of the grips and the breaking load is inaccurate because of the injury. This same statement may be made with respect to paper and rubber, and in many cases even to textile fabrics. Injury of this character is almost impossible with the form of grip described. In the testing of textiles, there is less disturbance of the lay of the longitudinal threads with this form of grip than with those in which the test strip is held between two surfaces strongly pressed together. The grips are therefore offered for the consideration of Committee D-13 on Textile Materials and they may also prove of interest to Committee D-11 on Rubber Products.

REPORT OF COMMITTEE E-1

ON

METHODS OF TESTING.

Committee E-1 has held two meetings since the annual meeting of the Society in 1915.

The committee has under consideration a number of subjects, most of which are still in the hands of sub-committees. It is prepared, however, to present a final report on, and to modify and recommend for adoption as standard by the Society, those portions of the report of last year which were printed in the 1915 Year-Book.[1]

The committee has taken into careful consideration all the discussion, and also the letters received regarding these matters, and in the light of them, recommends the following alterations in the Standard Methods for Testing:[2]

1. It is recommended that the following revisions be made in "Methods for Tension Tests of Metals:"

(*a*) Strike out Section 7, page 471, namely:

> "7. In determining the modulus of elasticity, the elastic limit (the load at which stress and strain are no longer proportional), and the least load producing a given permanent set, it is considered necessary that the extensometer be attached to two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen.",

and substitute the following:

> "7. In determining the modulus of elasticity, the elastic limit, and the proportional limit, the extensometer should be attached to at least two sides of the specimen, to compensate for unequal elongation, for improper holding, or for any slight bending that may exist in the specimen."

---

[1] "Tentative Revisions of Standard Methods of Testing," p. 632.

[2] 1915 Year-Book p. 470.

(*b*) In Section 8, page 472, change "on the two sides of the test piece" to read "on two or more sides of the test specimen."

(*c*) In Section 28 (*c*), pages 475 and 476, change "on opposite sides of the specimen, and when adjusted the points of attachment should be exactly opposite each other" to read "on two or more sides of the specimen."

2. It is recommended that the following section be inserted at the beginning of each of the Methods for (1) Tension Tests of Metals, on page 470, and (2) Compression Tests of Metals, on page 476, to be numbered Section 1, the numbering of the other sections being changed successively to correspond:

> "1. *Definition of Terms.*
>
> "*Elastic Limit* is the greatest load per unit of original cross-section which does not produce a permanent set.
>
> "This determination is rarely made in the commercial testing of materials.
>
> "*Proportional Limit* is the load per unit of original cross-section at which the deformations cease to be directly proportional to the loads.
>
> "This determination is rarely made in the commercial testing of materials.
>
> "*Yield Point* is the load per unit of original cross-section at which a marked increase in the deformation of the specimen occurs without increase of load. It is usually determined by the drop of the beam of the testing machine, or by the use of dividers."

3. It is recommended that the following revisions be made in the "Methods for Compression Tests of Metals:"

> (*a*) In Section 8, line 1, page 477, change "elastic limit" to read "the elastic and also the proportional limit."
>
> (*b*) In Section 8, line 4, page 477, strike out the word "elastic."
>
> (*c*) In Sections 10 and 11, page 478, change "elastic limit and yield point" to read "elastic limit, proportional limit and yield point."

The change recommended last year in Section 6, involving the method of determining modulus of elasticity, is not recommended for adoption this year. This question will be given further consideration by two sub-committees, one appointed to formulate descriptions of acceptable methods for determining modulus of elasticity, elastic limit, proportional limit, yield point, and any other properties which may be decided upon, in order that they may be available for ready reference, and the other to study the effect of speed of testing upon the determination of the yield point and tensile strength.

These sub-committees will be glad to receive from any member of the Society, information or suggestions that will aid them in their investigations. Communications should be addressed to the chairman of Committee E-1.

This report has been submitted to letter ballot of the committee, which consists of 29 members, of whom 25[a] have voted affirmatively, none negatively, and 4 have refrained from voting.

Respectfully submitted on behalf of the committee,

GAETANO LANZA,
Chairman.

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[a] One of these members desires the note under "Proportional Limit" omitted. Anothes desires that in the definition of "Elastic Limit" the expression "a permanent set" be changed to read "an appreciable permanent set," and in the definition of "Proportional Limit" the expression "to be directly proportional" be changed to read "to be appreciably directly proportional."

EDITORIAL NOTE.

The proposed revisions of the Standard referred to in this report were approved at the annual meeting and subsequently adopted by letter ballot of the Society on September 1, 1916. The Standard as thus revised appears in the 1916 Volume of A.S.T.M. Standards.

REPORT OF COMMITTEE E-5

ON

STANDING COMMITTEES.

This Committee consists of the Chairmen of all Standing Committees, or Representatives designated by the Respective Chairmen. The Duties of this Committee are the Formulation of *(a)* Regulations Governing Standing Committees, *(b)* Regulations Governing the Form but not the Substance of Specifications, and *(c)* the Classification of Standards.

Since the last annual meeting of the Society, Committee E-5 has held two meetings, one in September, 1915, the other in February, 1916. The first meeting was largely devoted to the consideration of changes in the designation of technical committees and standards, with a view to greater simplicity and consistency. The recommendation of Committee E-5 in that connection that the technical committees shall hereafter be known as standing committees and that the title of Committee E-5 be changed from that on technical committees to that on standing committees has been approved by the Executive Committee. The numerous changes in the titles of standing committees and in the designation of standards, recommended by Committee E-5 and approved by the Executive Committee, have been announced in Circular No. 103 to members, issued in November, 1915, and will, therefore, not be repeated here.

The activities of the committee have otherwise been mainly in the direction of amendments to the Regulations Governing Standing Committees, which were taken up either at its own initiative or in pursuance of instructions from the Executive Committee. These changes are all indicated in the appended regulations to this report in which the italicized parts (except side headings) represent new matter. The old matter which has either been cancelled or superseded has been enclosed in brackets.

Committee E-5 has also been called upon by the Executive Committee for advice concerning various matters affecting the by-laws and publications of the Society. Its cooperative relations with the Executive Committee in such matters, as well as the changes in the Regulations Governing Standing Committees, have led to no important differences of opinion but have been on the contrary entirely harmonious.

Committee E-5 has been advised that the Executive Committee intends to present at this annual meeting certain proposed changes in the by-laws whereby the contents of the Year-Book will hereafter be published biennially. If these changes in the by-laws should be approved by the Society, corresponding changes will have to be made in certain references to the present by-laws in the appended revised regulations.

This report has been submitted to letter ballot of the committee, which consists of 31 members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

EDITORIAL NOTE.

Since the annual meeting, the Regulations Governing Standing Committees have been revised to conform with the by-laws in their latest revised form. Also, certain changes have been made by Committee E-5 and the Executive Committee, and the Regulations in their latest revised form appear in the 1916 Volume of A.S.T.M. Standards.

APPENDIX.

REGULATIONS GOVERNING [TECHNICAL] *STANDING* COMMITTEES.

NOTE.—By action of the Executive Committee on January 6, 1912, the responsibility for the general Regulations Governing [Technical] *Standing* Committees is vested in Committee E-5 on [Technical] *Standing* Committees, with the understanding (1) that a proposed change in these Regulations originating with Committee E-5 shall be subject to approval by the Executive Committee of the Society; and (2) that the Executive Committee of the Society shall make no changes in these Regulations without first referring the same to Committee E-5.

Creation.—The creation of a [technical] *standing* committee shall be subject to the authorization of the Executive Committee, acting either on a recommendation adopted by majority vote at an annual meeting of the Society, or on its own initiative.

Appointments.—Appointments on [technical] *standing* committees shall be made by the Executive Committee subject to the following provisions:

1. On committees dealing with subjects having a commercial bearing, either an equal numeric balance shall be maintained between the representatives of producing and non-producing interests; or the latter may be allowed to predominate with the acquiescence of the former.
2. The classification of the members of a committee into producers and non-producers shall be left to each committee, subject to the following provisions, and with the understanding that a member dissatisfied with this classification has the right of appeal to the Executive Committee:

   (*a*) A member who stands in the relation of producer to any product within the province of the committee shall be classed as a producer, although at the request of the officers of the committee concerned, attention shall be called to the status of such members in a footnote worded as follows:

> These members of Committee.. classed as PRODUCERS, stand in the relation of PRODUCERS to certain products, and in that of NON-PRODUCERS to other products within the province of the committee.

(*b*) A nominally unattached expert, who is permanently retained by producing interests in the field of activities of the committee with which he is connected, shall be classed as a producer. The qualification "permanently retained" is to be understood to mean that the expert receives a regular monthly or yearly retainer from one or more producing interests under an indefinitely continuing arrangement.

3. As a general policy, only one representative from a given firm, company, corporation, laboratory, or other institution shall be eligible *to independent membership* on a given committee, although exceptions to this rule may be permitted at the discretion of the committee concerned. *If the membership on the committee is held in the name of a firm, company, corporation, laboratory, or other institution, more than one representative may, at the discretion of the committee concerned, participate in its activities, with the understanding that such representatives shall jointly command only a single vote.*

4. Additional appointments on existing committees shall be made only on the recommendation of, or with the approval of, such committees.

5. Only members of the Society shall be eligible, in general, to appointment on committees, although exceptions may be authorized by the Executive Committee in favor of representatives of government branches or other societies.

Preliminary Organization.—The President of the Society will appoint the chairman "pro tem.," of a new committee from the representatives of the non-producing interests. The chairman "pro tem.," after communicating with the other members of the committee, will fix the place and time of the first meeting. He may, at his discretion, appoint one or more members of the committee to prepare matter in advance for consideration at that meeting or he may prepare such matter himself. This procedure is recommended as calculated to economize time at the meeting and to afford a definite basis for discussion.

Permanent Organization.—At the first meeting of a committee a permanent organization shall be effected by the election of a permanent chairman from among the representatives of non-producing interests, and such other officers and sub-committees as the committee may desire. The duties and powers assigned to these officers and sub-committees, and the details of management and administration in general, shall be at the discretion of each committee, subject to the limitations of these regulations.

Election of Officers.—Every [technical] *standing* committee shall hold an election of officers at or before the annual meeting of the Society occurring in the even years. The term of office of every officer shall be two years and officers shall be eligible for re-election.

Resignations.—Proposed resignations from office or from membership on a [technical] *standing* committee shall be reported directly to the chairman or the secretary of the committee concerned, and the result of any action taken in such matters shall be reported to the Secretary-Treasurer of the Society.

Proxies.—A member of a standing committee shall be authorized to delegate any desired individual as his proxy with voting power, but no individual shall have more than one vote at a meeting of a committee.

Sub-Committees.—Sub-Committees on proposed [standards] *complete standard specifications for materials* shall consist of not fewer than six members, and at least one-half of the membership shall be composed of non-producers. *Departures from this requirement for exceptional reasons may be authorized by the Executive Committee.*

Reports.—The reports of [technical] *standing* committees shall be presented at the annual meetings. Such reports must first have been submitted to letter ballot of the committee and must have received the approval of the majority of those voting. A statement of the following form shall appear at the close of every committee report:

> This report has been submitted to letter ballot of the committee which consists of .... members, of whom .... have voted affirmatively .... negatively, and .... have refrained from voting.

Dissenting members shall have the right to present minority reports individually or jointly.

Standards.—The term "Standards" shall be applied collectively to (*a*) standard specifications, (*b*) standard tests, (*c*) standard methods, and (*d*) standard definitions.

The term "Standard Specifications" shall be applied to specifications designed to govern the purchase of materials. Such specifications may or may not include reference to tests, but they shall include limits for physical, chemical or other properties.

The term "Standard Tests" shall be applied to prescribed directions for tests of specific materials, but shall not include limits for physical, chemical or other properties.

The term "Standard Methods" shall be applied to prescribed methods of procedure in the conduct of physical, chemical or other tests.

The term "Standard Definitions" is self-explanatory.

In the preparation of proposed standards the consideration of matters of engineering design or construction shall not in general be regarded as falling within the province of the Society. If, however, it should appear to a given committee that the consideration of such matters is, for special reasons, indispensable in specifications designed to cover the customary relations between the producers and consumers of a given product, then reference to such matter in proposed specifications for that product shall be permitted within the scope necessary for the particular purpose above stated. Proposed standards embodying features of the character in question shall be submitted by the committee concerned to the Executive Committee for consideration and comment, not later than the quarterly *meeting immediately preceding the annual meeting at which the proposed standards are to be presented.*

Proposed new standards or the proposed amendment of existing standards must originate in the particular committee within whose province such standards properly belong. No action affecting standards shall be taken by any [technical] *standing* committee except at meetings called for that purpose. Action at such meetings shall be subject to majority vote of those voting, and subsequently to majority vote of those voting on letter ballot of the entire committee. The results of each letter ballot as to the number of affirmative votes, the number of negative votes, and the number of members not voting, shall be announced in the report of the committee to the Society. Dissenting members shall have the right to present minority reports, individually or jointly, at the annual meeting of the Society at which the majority report is presented.

Any recommendations affecting standards must be transmitted to the Secretary-Treasurer of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary-Treasurer to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter.

Any recommendations affecting standards presented by the appropriate committees at the annual meeting of the Society will be subject to the following provisions in the by-laws of the Society:

ARTICLE VI

PROCEDURE GOVERNING THE ADOPTION OF STANDARDS.

SECTION 1. The term "Standards" shall be applied collectively to standard specifications, standard tests, standard methods, and standard definitions.

Proposed new standards or proposed amendments of existing standards shall be presented at the annual meeting. At this meeting amendments may be made by a two-thirds vote of those voting. The proposed new standards or the proposed amendments of existing standards, as presented or as amended, shall be printed, on two-thirds vote of those voting, in the Year-Book under a section designated "Tentative Standards," on which written discussions addressed to the appropriate committee shall be invited. At the next annual meeting these proposed new standards or proposed amendments of existing standards shall be subject to amendment by a two-thirds vote of those voting, and to reference by a like vote to letter ballot of the Society. A two-thirds vote of those voting shall be required for adoption.

The above requirement by which final action on proposed new standards or proposed amendments of existing standards shall be deferred for one year may, for exceptional reasons, be waived by a nine-tenths vote of those voting at the annual meeting at which they are first presented. In that case the above provisions as to amendments, as to reference to letter ballot, and as to adoption shall remain unaffected.

The term "Recommended Practice" shall be applied to processes and methods not ordinarily subject to contract between purchaser and manufacturer. The above requirements governing action on new standards or proposed amendments of existing standards shall be applicable also to proposed Recommended Practice.

Sec. 2.—Reports, resolutions and recommendations pertaining to or involving the use, or proposed use, in a Standard or Tentative Standard, of any device or process which forms the subject matter of any existing patent, shall first be submitted to the Executive Committee, and shall be submitted to the Society only with the approval of the Executive Committee.

Cooperation with Other Committees.—A committee may, at its discretion, invite the cooperation of committees of other societies on like or cognate subjects, provided such relations shall entail no obligations at variance with these regulations, and shall impose no restrictions upon the free and independent action of the committee.

A committee desiring to bring about the appointment of similar committees by other societies for purposes of cooperation shall address a recommendation to that effect to the Executive

Committee and, on the approval of the latter, negotiations to the desired end shall be conducted on behalf of the Executive Committee by the Secretary-Treasurer of the Society.

Publication.—Committees shall have no right to issue matter for publication through other than the regular Society channels, unless so authorized, for exceptional reasons, by the Executive Committee.

Current Expenses.—Expenses for postage incurred in connection with the business of committees will be refunded by the Secretary-Treasurer of the Society on vouchers approved by the chairman of these committees.

Stationery.—Correspondence relating to the business of committees or sub-committees shall be conducted on official stationery which will be furnished by the Secretary-Treasurer of the Society.

Extraordinary Expenses.—Expenses for items other than postage will not be assumed by the Society, unless such expenditures were incurred in pursuance of previous authorization of the Executive Committee, on recommendation of the chairman of the committee concerned, and within amounts specifically fixed by the Executive Committee.

Special Funds.—Committees engaged on subjects having a commercial bearing shall be authorized to solicit contributions from manufacturers towards research funds. Contributions from consumers to funds for this and other purposes shall be solicited only by the Executive Committee. All funds thus collected shall be transmitted to the Secretary-Treasurer of the Society and deposited by him in bank and placed to the credit of the committees on the books of the Society, subject to disbursement only on vouchers signed by the chairman of the committee concerned.

Salaries and Fees.—Committees shall not be authorized to pay salaries or professional fees in any form to any of their officers or members. Assistants in connection with research work may be engaged at salaries or special compensation fixed by the committees concerned, provided that funds for such salaries or compensations shall previously have been deposited with the Secretary-Treasurer of the Society. Payments for such purposes shall be made by the Secretary-Treasurer of the

Society only on vouchers approved by the chairman of the committee concerned.

Discharge of Committees.—[Technical] *Standing* committees may be discharged by the Executive Committee, either at their own request or with their consent, on the completion of the work for which they were appointed or in consequence of protracted inactivity. A [technical] *standing* committee which fails to present a report at three successive annual meetings of the Society will be required to show cause, in a written communication to the Executive Committee, why it should not be discharged.

[Technical] *Standing* committees may be discharged for cause by the Executive Committee at its own initiative.

AMERICAN REPRESENTATION ON COMMITTEES OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

Nominations.—In making nominations for appointment of American members on International committees on a subject, falling within the province of an American [technical] *standing* committee, the sense of the latter committee as to the selection of the nominee shall be obtained before final action on the part of the Executive Committee.

Relation between American Representatives on International Committees and American Committees on the same Subjects.—The American representative or representatives on an International committee dealing with subjects falling within the province of an American [technical] *standing* committee shall keep that committee fully advised as to the important developments in the work of the International committee. Formal recommendations to the International committee on the part of such representative or representatives, and their vote on letter ballot of that committee, shall be subject to advance approval on the part of the American committee.

RECOMMENDATIONS TO [TECHNICAL] *STANDING* COMMITTEES.

The following recommendations to [technical] *standing* committees have been approved by the Executive Committee and Committee E-5:

It is recommended that the various [technical] *standing* committees should formulate proposed standard definitions of terms in matters falling in their respective fields, and that in the case of terms which come within the province of two or more committees, such definitions be formulated by joint action, through sub-committees, on the part of the committees concerned. Such proposed standard definitions of terms will be subject to adoption by the Society under the provisions of the by-laws and the Regulations Governing [Technical] *Standing* Committees.

An alphabetic glossary of standard definitions of terms will be published in the Year-Book as soon as their number appears to warrant such action.

COOPERATIVE POSSIBILITIES BETWEEN U. S. GOVERNMENT LABORATORIES AND A. S. T. M. STANDING COMMITTEES.

The basis on which various government branches may cooperate with the committees of this Society are indicated on pages 711–713 of the 1915 Year-Book. Any committee desiring to establish such cooperative relations shall address a recommendation to that effect to the Executive Committee, and on approval of the latter, negotiations to the desired end shall be conducted by the Secretary-Treasurer of the Society.

REPORT OF COMMITTEE E-6

ON

PAPERS AND PUBLICATIONS.

It has not been found necessary during the past year to hold a general meeting of Committee E-6. The acceptances of papers have been passed upon by the Advisory Committee, guided in some instances by expert advice of non-members of the committee whose cooperation is hereby gratefully acknowledged.

The experience this year in connection with the 26 committee reports which, exclusive of that of the Executive Committee, appear on the program, emphasizes the importance of endeavoring to devise improved methods governing such reports. An effort in that direction will be made during the ensuing year. It is sometimes difficult to determine whether certain matters affecting committee reports should be dealt with by Committee E-6 or by Committee E-5 on Standing Committees. Among these the following may be mentioned:

1. The present Regulations Governing Standing Committees provide that:

> "Any recommendations affecting standards must be transmitted to the Secretary-Treasurer of the Society at least eight weeks in advance of the date of the annual meeting, and copies of these recommendations, in printed form, must be mailed by the Secretary-Treasurer to every member of the Society not less than four weeks before the annual meeting, so that members may come to the meeting prepared to discuss such recommendations, and that members not intending to be present at the meeting may contribute discussions by letter."

According to this regulation the manuscripts of the 19 committee reports, this year, affecting standards should have been sent to the Secretary-Treasurer not later than May 2, and they should all have been included in the first instalment of preprints mailed to the membership at large on May 30. As may be seen from Table I, of the nine reports received after May 2 five, of which the average date of receipt was May 10, were included in this first instalment, but the remaining four, for which the average date of receipt was May 21, could not be printed in time to make this possible. These reports were accordingly issued on June 15 in connection with the second instalment of preprints.

It must be left to the Society in annual meeting assembled to determine whether the violation of the regulations by committees, to the extent of rendering it impossible to comply with the requirements governing the limiting date for the distribution of their reports, is to be taken into account in the consideration of proposed standards embraced in such reports. A more important thing is, however, to endeavor to devise measures calculated to hold committees to stricter accountability in future.

TABLE I.—ANALYSIS OF PREPRINTING.

Instalment No.	Date of Mailing.	Committee Reports.										Papers.		Total.	
		Affecting Standards; Due May 2.				Not Affecting Standards.				Total.					
		Received before May 2, on Average Date Shown.		Received after May 2, on Average Date Shown.		Received before May 2, on Average Date Shown.		Received after May 2, on Average Date Shown.							
		No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.	No.	Pages.
1	May 30.....	10 (April 19)	190	5 (May 10)	117	..	..	..	..	15	307	8 (April 16)	103	23	410
2	June 15.....	..	..	4 (May 21)	131	1 (April 15)	2	5[a] (May 18)	64	10[a]	197	8 (May 6)	148	18[a]	345
3	June 21.....	..	..	.	..	..	..	2 (May 31)	39	2	39	4 (May 29)	52	6	91
4	Not mailed; printed for Annual Meeting only......	..	..	..	.	.	..	3[b] (June 18)	34	3[b]	34	2 (June 9)	57	5[b]	91
						Totals...............				30[a, b]	577	22	360	52[a, b]	937

[a] Includes two preprints which are part of and complete two committee reports in the first instalment.

[b] Includes one preprint which is part of and completes a committee report in the first instalment.

NOTE.—In addition to the above, 3 discussions of papers and committee reports, totaling 11 pages, have been preprinted.

2. There has been a tendency on the part of certain committees to transmit, for publication in connection with the

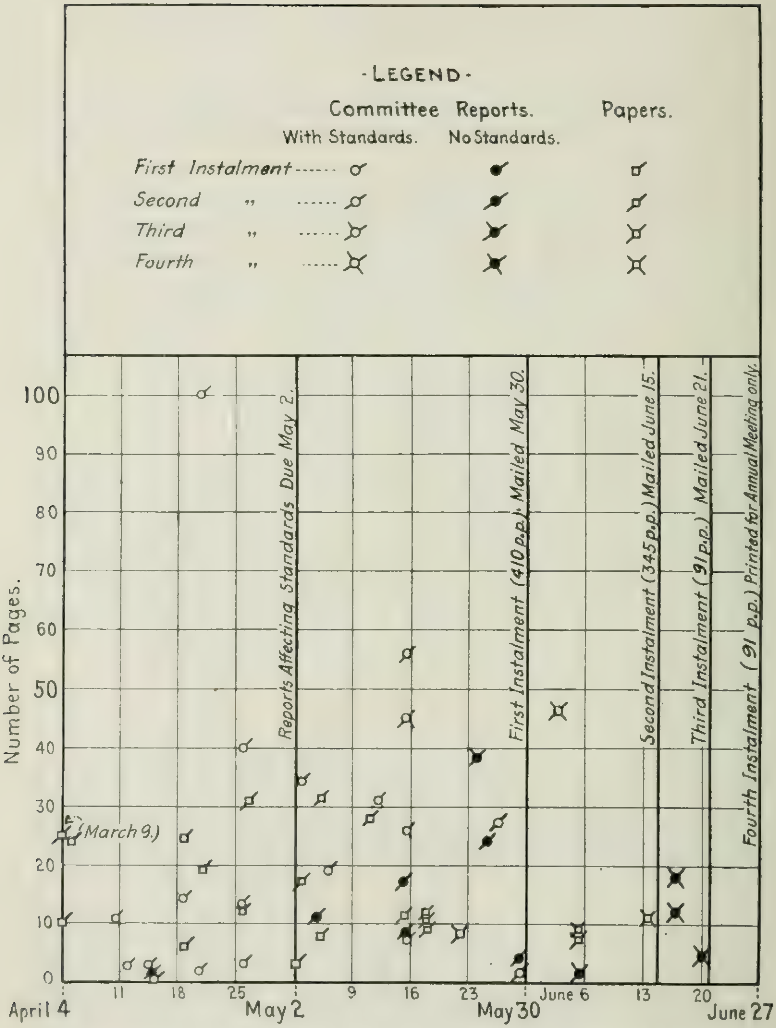

FIG. 1.—Statistics of Preprints. Position of Symbol Indicates Content as to Number of Pages and Date of Receipt of Manuscripts of Every Paper and Committee Report.

reports of their committees, reports of sub-committees which have not previously been presented for discussion to the parent committee, and on which, in some instances, little or no comment is made in the report of the main committee. It would seem that the principle that sub-committee reports should not be presented to the Society until they have received due consideration by the parent committees, and that the latter are expected to assume the responsibility for their presentation, with such comments or recommendations as may seem pertinent, should be strictly observed.

3. Committee reports are sometimes, and for various reasons, considerably modified in editing them for publication. Such modifications are subject to the approval of the chairmen of the committees concerned. In view of the possibility of such changes in editing it would seem desirable that the letter ballot of the committee on such reports should be deferred until the reports have been reduced to their final form for publication.

4. It seems desirable that effective measures should be taken towards obtaining a full vote on committee reports on the part of members of the committee concerned. If, as sometimes happens, a considerable percentage of the members are reported as "not voting," the inference is that a substantial element on the committee is not sufficiently interested in its work to take the trouble to vote. If that inference is undeserved its basis should be removed; otherwise means should apparently be found for eliminating inactive and indifferent members. An effort will be made towards bringing about an early meeting of the Advisory Committees of Committee E-5 and Committee E-6 for the preliminary consideration of the above and other matters of mutual interest to both committees.

The accompanying diagram (Fig. 1) affords a more comprehensive and detailed view of the general situation relative to preprints with reference to (1) the date of receipt of manuscripts; (2) the number of printed pages in each item; and (3) the contents as to pages, and the mailing date of each instalment of preprints.

Notwithstanding the lateness of the receipt of many manuscripts, it has been found possible, through extra efforts and by the adoption of a night schedule for printing, to have every item on the program available at the annual meeting in printed form.

The comparative data for preprints since 1913, when preprinting was first undertaken on an extensive scale, are as follows:

Year.	Preprints.			On Program, but not Preprinted, pages.
	Circulated in Advance, pages.	Not Circulated in Advance, pages.	Total, pages.	
1913	461	238	699	81
1914	668	260	928	11
1915	891	76	967	0
1916	846	91	937	0

In view of the abnormal conditions of the paper market, paper of two different grades, and both of somewhat inferior quality, has been used this year for the preprints. For the Year-Book and the Proceedings a stock of paper of the regular quality was purchased and placed in storage by the publishers some months ago.

This report has been submitted to letter ballot of the committee, which consists of nine members, all of whom have voted affirmatively.

Respectfully submitted on behalf of the committee,

EDGAR MARBURG,
Chairman.

TENTATIVE STANDARDS

The term Tentative Standards is applied to proposed Standards which are printed for one or two years with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action towards the adoption of such Tentative Standards by formal action of the Society.

Members of the Society and others are invited to direct written criticism of any of these Tentative Standards to the officer of the appropriate committee whose name and address appear in connection with the title of each Tentative Standard.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
STEEL TRACK SPIKES.

Serial Designation: A 65 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

I. MANUFACTURE.

ocess. 1. The steel may be made by the Bessemer or open-hearth process.

II. PHYSICAL PROPERTIES AND TESTS.

nsion Tests. 2. The full-size finished spikes, or the full-size bars from which the spikes are made, shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	55 000
Yield point, lb. per sq. in.	0.5 tens. str.
Elongation in 2 in., per cent	25

nd Tests. 3. (*a*) The body of the full-size finished spikes shall bend cold through 180 deg. flat on itself, without cracking on the outside of the bent portion.

(*b*) The head of the full-size finished spikes shall bend backward to the line of the face of the spike without cracking on the outside of the bent portion.

Number of

4. (*a*) One tension and one bend test of each kind shall be made from each lot of 10 tons or fraction thereof.

(*b*) If any test specimen develops flaws, it may be discarded and another specimen substituted.

Retests.

5. If any tension test specimen breaks more than $\frac{3}{4}$ in. from the center of the gage lenght, a retest shall be allowed.

III. WORKMANSHIP AND FINISH.

Workmans

6. The spikes shall conform to the dimensions specified by the purchaser. A variation of $\frac{1}{64}$ in. under the specified dimension of the body of the spike, measured from the face to the back, and a variation of $\frac{1}{32}$ in. over the specified dimension of the body of the spike, measured across the face, will be permitted. A variation of $\frac{3}{32}$ in. over and $\frac{1}{32}$ in. under the specified dimensions of the head of the spike will be permitted. A variation of $\frac{1}{8}$ in. from the specified length of the spike, measured from the under side of the head to the point, will be permitted. A variation of 1 deg. in the specified angle of the under side of the head of the spike will be permitted.

Finish.

7. The finished spikes shall be free from injurious defects and shall have a workmanlike finish.

V. INSPECTION AND REJECTION.

Inspection.

8. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the spikes ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the spikes are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

9. Spikes which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

AMERICAN SOCIETY FOR TESTING MATERIALS
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TENTATIVE SPECIFICATIONS
FOR
STEEL SCREW SPIKES.

Serial Designation: A 66 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

I. MANUFACTURE.

Process. 1. The steel may be made by the Bessemer or open-hearth process.

Finishing. 2. The heads of the spikes shall be formed and the threads rolled at a temperature not less than 750° C.

II. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 3. The full-size finished spikes shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	60 000
Yield point, lb. per sq. in.	0.5 tens. str.
Elongation in 2 in., per cent	20

Bend Tests. 4. The full-size finished spikes shall bend cold through 90 deg. around a pin the diameter of which is equal to three times the diameter of the spike, without cracking on the outside of the bent portion.

Number of Tests. 5. (*a*) One tension and one bend test shall be made from each lot of 100 kegs or fraction thereof.

(*b*) If any spike tested develops flaws, it may be discarded and another spike substituted.

6. (*a*) If the percentage of elongation of any tension test spike is less than that specified in Section 3, a retest shall be allowed. **Retests.**

(*b*) If any tension test spike breaks more than $\frac{3}{4}$ in. from the center of the gage length, a retest shall be allowed.

III. WORKMANSHIP AND FINISH.

7. The spikes shall conform to the dimensions specified by the purchaser. The head shall be concentric with, and firmly joined to, the body of the spike. The threads shall be sharp and true to gage and of the pattern specified by the purchaser. A variation of $\frac{1}{32}$ in. over and under the specified diameter of the unthreaded portion of the body of the spike will be permitted. A variation of $\frac{1}{32}$ in. over the specified diameter of the threaded portion of the spike will be permitted. A variation of $\frac{1}{16}$ in. under and $\frac{1}{8}$ in. over in the reach of the head of the spike will be permitted. A variation of $\frac{1}{8}$ in. from the specified length of the spike will be permitted. **Workmanship.**

8. The finished spikes shall be free from injurious defects and shall have a workmanlike finish. **Finish.**

IV. MARKING.

9. A letter or brand indicating the manufacturer shall be pressed on the head of the spike while it is being formed. **Marking.**

V. INSPECTION AND REJECTION.

10. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the spikes ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the spikes are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

11. Spikes which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified. **Rejection.**

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TENTATIVE SPECIFICATIONS
FOR
STEEL TIE PLATES.

Serial Designation: A 67 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

I. MANUFACTURE.

Process. 1. The steel shall be made by the open-hearth process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 2. The steel shall conform to the following requirements as to chemical composition:

Phosphorus........................... not over 0.05 per cent

Ladle Analyses. 3. An analysis from each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulfur. This analysis shall be made from drillings taken at least $\frac{1}{8}$ in. beneath the surface of a test ingot obtained during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirement specified in Section 2.

Check Analyses. 4. An analysis may be made by the purchaser from a finished tie plate representing each melt. The phosphorus content thus determined shall not exceed that specified in Section 2 by more than 25 per cent.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. (*a*) Except as specified in Paragraph (*b*), the tie plates shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	64 000
Yield point, lb. per sq. in.	0.5 tens. str.
Elongation in 2 in., per cent	18

(*b*) Tie plates in which the material required to be punched is $\frac{5}{8}$ in. or greater in thickness, shall conform to the following requirements as to tensile properties:

Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., lb. per sq. in.	0.5 tens. str.
Elongation in 2 in., min., per cent	25

Bend Tests.

6. The bend test specimen specified in Section 7 shall bend cold through 180 deg. around a pin the diameter of which is equal to twice the thickness of the specimen, without cracking on the outside of the bent portion.

Test Specimens.

7. (*a*) The tension and bend test specimens shall be taken from the finished tie plates. They shall be cut so that the sides of the specimens are parallel with the direction in which the tie plates have been rolled.

(*b*) Tension test specimens may conform to the essential dimensions shown in Fig. 1. In this case they shall have filleted shoulders, or threaded ends, to fit into the holders on the testing machine in such a way that the line of action of the force exerted by the testing machine shall concide with the axis of the specimen.

Or, tension test specimens may be rectangular in section, in which case they shall be not less than $\frac{1}{2}$ in. in width between the planed sides, and shall have two parallel faces as rolled.

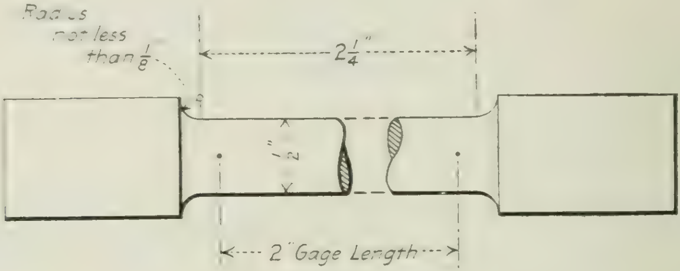
(*c*) Bend test specimens shall be rectangular in section, not less than $\frac{1}{2}$ in. in width between the planed sides, and shall have two parallel faces as rolled, with the corners rounded to a radius not over $\frac{1}{16}$ in.

(*d*) When the tie plates are of such a design that the rectangular specimens cannot be obtained without projecting ribs, these shall be planed off before the tests are made.

Number of Tests. 8. (*a*) One tension and one bend test shall be made from each melt.

(*b*) If any test specimen shows defective machining or develops flaws, or if it breaks outside the gage length, it may be discarded and another specimen substituted.

Retests. 9. (*a*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5, a retest shall be allowed.



Note – The Gage Length, Parallel Portions and Fillets shall be as Shown, but the Ends may be of any Form which will Fit the Holders of the Testing Machine.

FIG. 1.

(*b*) If any tension test specimen breaks more than $\frac{3}{4}$ in. from the center of the gage length, a retest shall be allowed.

IV. WORKMANSHIP AND FINISH.

Workmanship. 10. The tie plates shall be smoothly rolled, true to templet, and shall be straight and out of wind on the surface which will form the bearing for the rail. They shall be sheared to the length and punched to the dimensions specified by the purchaser, with the following permissible variations:

(*a*) For plates with shoulders parallel to the direction of rolling, variation of $\frac{1}{32}$ in. in thickness, and $\frac{1}{8}$ in. in width and length will be permitted.

(*b*) For plates with shoulders perpendicular to the direction of rolling, a variation of $\frac{1}{32}$ in. in thickness, $\frac{1}{8}$ in. in width and $\frac{1}{4}$ in. in length will be permitted.

Finish. 11. The finished tie plates shall be free from burrs and other surface deformations caused by the shearing and punching; they shall also be free from other injurious defects and shall have a workmanlike finish.

V. MARKING.

Marking. 12. The name or brand of the manufacturer, the section and the year of manufacture shall be rolled in raised letters and figures on the outside of the shoulder of the plate, and a portion of this marking shall appear on each finished tie plate.

VI. INSPECTION AND REJECTION.

Inspection. 13. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the tie plates ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tie plates are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 14. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 4 shall be reported within five working days from the receipt of samples.

(*b*) Tie plates which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing. 15. Samples tested in accordance with Section 4, which represent rejected tie plates, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE SPECIFICATIONS

FOR

CARBON-STEEL BARS FOR RAILWAY SPRINGS WITH SPECIAL SILICON REQUIREMENTS.

Serial Designation: A 68 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

Classes. 1. (*a*) These specifications cover carbon-steel bars with special silicon requirements, to be used for the manufacture of railway springs.

(*b*) The bars are divided into two classes, determined by the carbon ranges specified in Section 3. The choice of the class of bar to be used for the manufacture of any spring will depend on the design of the spring and the stresses and service for which it is intended. The purposes for which these classes are frequently used are as follows:

Class A, for elliptical and helical springs;
Class B, for helical springs.

I. MANUFACTURE.

Process. 2. The steel may be made by the open-hearth, crucible or electric process.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The steel shall conform to the following requirements as to chemical composition:

Elements Considered.	Class A.	Class B.
Carbon, per cent	0.90 - 1.10	0.95 - 1 15
Manganese, max., per cent	0.50	0.50
Phosphorus, max., per cent	0.05	0.05
Sulfur, max., per cent	0.05	0.05
Silicon, per cent	0.25 - 0.50	0.25 - 0.50

Ladle Analyses. 4. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 3. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analyses. 5. Analyses may be made by the purchaser from finished bars representing each melt. The chemical composition thus determined shall conform to the requirements specified in Section 3.

III. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Permissible Variations. 6. The permissible variations in the width and thickness of the bars shall be agreed upon by the manufacturer and the purchaser.

IV. FINISH.

Finish. 7. The finished bars shall be free from injurious defects and shall have a workmanlike finish.

V. MARKING.

Marking. 8. The bars shall, when loaded for shipment, be properly separated and marked with the name or brand of the manufacturer and the melt number for identification.

VI. INSPECTION AND REJECTION.

Inspection. 9. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the bars ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the bars are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 10. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5 shall be reported within five working days from the receipt of samples.

(*b*) Bars which show injurious defects subsequent to their acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing. 11. Samples tested in accordance with Section 5, which represent rejected bars, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE SPECIFICATIONS

FOR

ELLIPTICAL SPRINGS FOR AUTOMOBILES.

Serial Designation: A 69 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

Basis of Purchase.

1. (*a*) These specifications cover all elliptic springs for automobiles.

(*b*) The manufacturer and the purchaser shall agree on the type and grade of steel bars to be used.

(*c*) If carbon-steel bars, silico-manganese-steel bars or chrome-vanadium-steel bars are specified, the bars shall conform, respectively, to the Standard Specifications for Carbon-Steel Bars for Vehicle and Automobile Springs (Serial Designation: A 58), the Standard Specifications for Silico-Manganese-Steel Bars for Automobile and Railway Springs (Serial Designation: A 59), or the Standard Specifications for Chrome-Vanadium-Steel Bars for Automobile and Railway Springs (Serial Designation: A 60), of the American Society for Testing Materials.[1]

(*d*) Drillings for chemical analysis shall be taken from pieces sheared from the bars during the process of manufacture, and not from a finished spring, unless otherwise agreed upon.

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[1] See 1916 Volume of A.S.T.M. Standards.—Ed.

I. CHEMICAL PROPERTIES AND TESTS.

Check Analyses. 2. (*a*) An analysis may be made by the purchaser from a sample representing each size of spring steel involved. The chemical composition thus determined shall conform to the requirements of Section 1 (*c*).

(*b*) Drillings for analysis shall be taken from the unworked portion of the bars and shall represent the full cross-section after rejecting any decarburized material.

(*c*) In case of dispute, check and arbitration analyses of carbon steel shall be made in accordance with the Standard Methods for Chemical Analysis of Plain Carbon Steel (Serial Designation: A 33) of the American Society for Testing Materials,[1] the carbon being determined by the "direct-combustion" method; and of alloy steel, in accordance with the Standard Methods for Chemical Analysis of Alloy Steels (Serial Designation: A 55), of the American Society for Testing Materials.[1]

II. WORKMANSHIP.

Inspection. 3. The purchaser or his representative may examine all springs in each lot for workmanship and general dimensions.

Workmanship. 4. (*a*) The springs shall be submitted for inspection complete in the condition required by the drawings, and shall conform to these drawings with the permissible variations specified in this section and Section 7. Dimensions which affect the contour only and do not affect the interchange or service of the spring need only be approximated.

(*b*) The springs shall have the plates properly graduated in length, properly bent, and fitted reasonably true to the curves specified.

III. PHYSICAL PROPERTIES AND TESTS.

Number of Tests. 5. All of the springs may be tested.

Methods of Testing. 6. (*a*) Full-elliptic springs shall be tested in the upright position. One-quarter-elliptic, half-elliptic, three-quarter-elliptic, and cantilever springs shall be tested in the inverted position, and shall be so supported as to give free lateral movement on compression while remaining in position selected for test. Methods of supporting and measuring the various types of springs are illustrated in Figs. 1 to 7, inclusive.

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[1] See 1916 Volume of A.S.T.M. Standards.—ED.

(*b*) The anvil or pressure block of the testing machine shall be of the form shown in Fig. 8.

(*c*) Unless otherwise specified, all measurements of height are to be made as follows: in half-elliptic springs (Figs. 1 and 2), between the surfaces of the pressure block and a line joining the centers of the eyes (or through the points of support where there are no eyes); in full and three-quarter-elliptic springs (Figs. 3 and 4), between the surfaces of the upper and lower pressure blocks; in one-quarter-elliptic springs (Figs. 5 and 6), between the center of the eye (or point of support where there is no eye) and the supporting pad of the spring, measured at right angles to the surface of the latter; and in half-elliptic cantilever springs (Fig. 7), between the center of the floating eye and a horizontal plane passing through the lower surface of the spring (in inverted position) at the center bolt.

(*d*) In conducting tests, all measurements of height shall be taken to at least the nearest $\frac{1}{64}$ in. All readings of load shall be taken to at least the nearest 5 lb.

(*e*) *Maximum Test Load.*—The maximum test load required in Section 7 shall be twice the specified normal load, unless such a test load produces a deflection greater than the maximum deflection possible under the car. In the latter case, the maximum test load used shall be the load producing the maximum deflection possible under the car.

(*f*) *Application of Load.*—The application of the loads under which the height is to be measured as specified in Section 7 shall be made gradually and in such a way that the required load shall not be exceeded. If it is exceeded, the load shall be released to not more than one-half the required load and then increased to the required load under which the height is to be measured. The spring shall not be rapped or otherwise disturbed during the test.

Physical Tests.

7. The physical properties of the springs shall be determined as follows:[1]

(*a*) *Loaded Height.*—The loaded height is the height when the specified normal load is applied after the maximum test load as defined in Section 5 (*e*) has been applied and fully released three times. The loaded height in the case of pleasure

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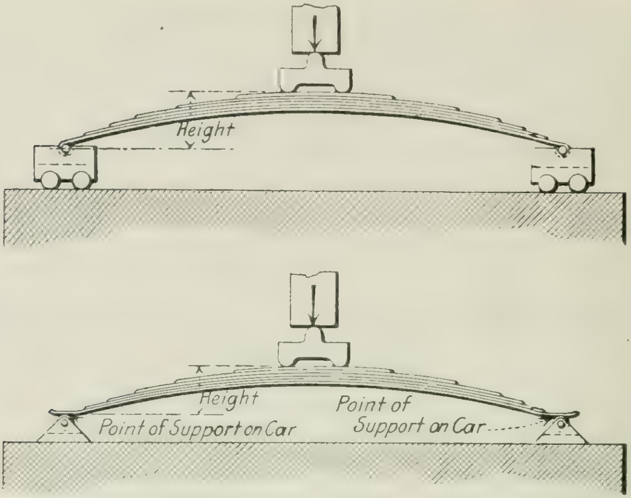
[1] See Section 13, "Appendix," for a convenient routine of tests.



FIGS. 1 AND 2.—Half-Elliptic Spring Compression Test Support.

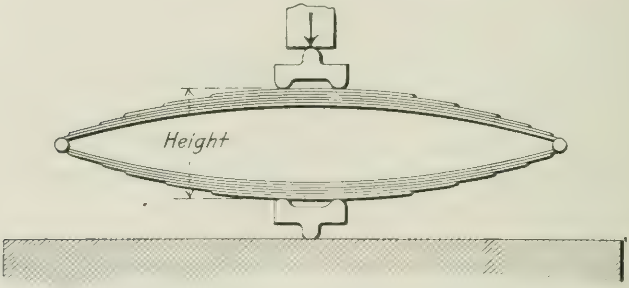


FIG. 3.—Full-Elliptic Spring Compression Test Support.

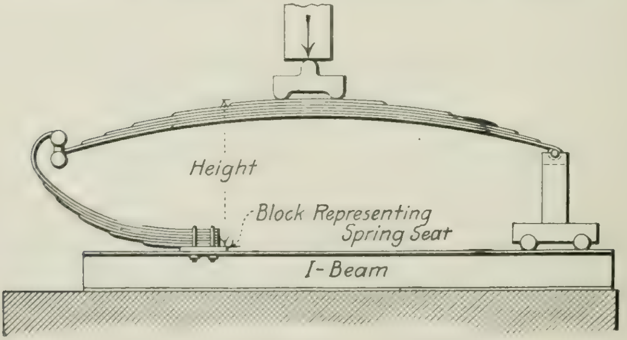
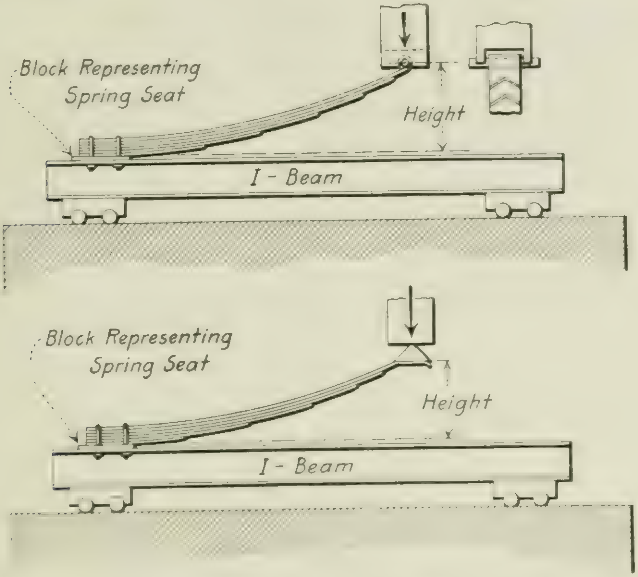


FIG. 4.—Three-Quarter-Elliptic Spring Compression Test Support.

cars, unless otherwise specified, shall not be less, but may be ¼ in. and ⅜ in. more than that specified for front and rear springs, respectively.


Block Representing Spring Seat
Height
I - Beam
Block Representing Spring Seat
Height
I - Beam

FIGS. 5 AND 6.—One-Quarter-Elliptic Spring Compression Test Support.

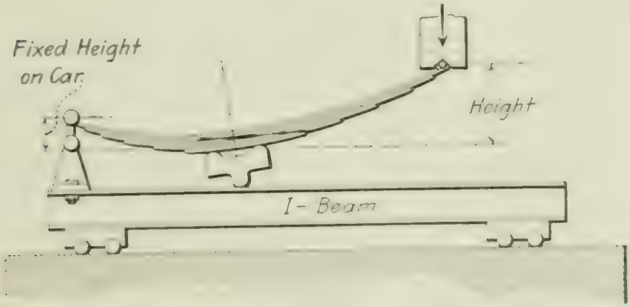


FIG. 7.—Half-Elliptic Cantilever Spring Compression Test Support.

(*b*) *Permanent Set.*—The permanent set is the difference, if any, between two successive measurements of the height under a load equal to 75 per cent of the specified normal load.

This load shall be applied for the first time after the maximum test load has been applied and fully released three times, and for the second time after the maximum test load has been applied again and fully released. The following two requirements shall be met:

(1) The permanent set shall not exceed $\frac{1}{16}$ in.;

(2) If there is any permanent set not exceeding $\frac{1}{16}$ in., the maximum test load shall be applied and fully released two additional times and a load equal to 75 per cent of the specified normal load applied a third time. The height under this third application shall not be less than that measured under the second application.

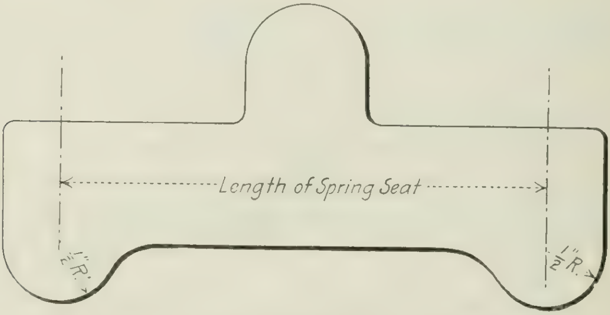


FIG. 8.—Pressure Block for Testing Springs.

(c) *Flexibility.*—The flexibility, when specified, shall be expressed in pounds per inch of deflection. It shall be determined by measuring the height under 75 per cent of the specified normal load and the height under 125 per cent of that load, and dividing the difference in loads by the difference in heights. The quotient is the flexibility in pounds per inch of deflection and shall not vary from that specified more than 5 per cent.

IV. MARKING.

Marking. 8. (*a*) The name or brand of the manufacturer, the year and month of manufacture, and if specified, the purchaser's class or part number, shall be legibly stamped on each spring at a place not detrimental to the life or service of the spring, on the exposed end of the compression side of a plate.

(*b*) Any stamping by the inspector shall be so placed as not to be detrimental to the life or service of the spring.

V. INSPECTION AND REJECTION.

Inspection. 9. The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the springs ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the springs are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 10. Unless otherwise specified, any rejection based on tests made in accordance with Section 2 shall be reported within five working days from the receipt of samples.

Rehearing. 11. Samples tested in accordance with Section 2, which represent rejected springs, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

Reworking. 12. Any springs which fail to meet the requirements as to dimensions or physical tests may be again submitted after being remade by the manufacturer, such remaking to consist of insertion of new plates or of annealing, reforming and retreating of old plates. No springs shall contain cold reworked plates.

APPENDIX.

Recommended Routine for Testing.

Routine for Testing.

13. The physical tests required by Section 7 for the determination of loaded height, permanent set, and flexibility, can be carried out with the least possible number of operations by using the following routine of loading and measuring:

(1) Apply the maximum test load as defined in Section 6 (*e*) and release fully. Repeat this operation twice.

(2) Apply 75 per cent of the specified normal load, and measure the height (denote by h_1). This height is the first measurement for permanent set and for flexibility.

(3) Apply the specified normal load and measure the height (denote by h_2). This is the loaded height.

(4) Apply 125 per cent of the specified normal load and measure the height (denote by h_3). This is the second measurement for flexibility.

(5) Apply the maximum test load and release fully.

(6) Apply 75 per cent of the specified normal load and measure the height (denote by h_4). This is the second measurement for permanent set. If h_4 is less than h_1 the difference is the permanent set. If the permanent set does not exceed $\frac{1}{16}$ in., the following operations are required:

(7) Apply the maximum test load and release fully. Repeat this operation once.

(8) Apply 75 per cent of the specified normal load, and measure the height (denote by h_5). This is the third measurement for permanent set

Then:—

Loaded Height $= h_2$.

Permanent Set $= h_1 - h_4$, and springs are rejected if this is more than $\frac{1}{16}$ in. or if h_5 is less than h_4.

$$Flexibility = \frac{\frac{1}{2} \times \text{specified normal load}}{h_1 - h_3}$$

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TENTATIVE SPECIFICATIONS

FOR

BOILER AND FIREBOX STEEL FOR STATIONARY SERVICE.

Serial Designation: A 70 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. C. L. Warwick, Secretary of Committee A-1 on Steel, University of Pennsylvania, Philadelphia, Pa.

1. These specifications cover two grades of steel for boilers for stationary service, namely, flange and firebox. **Grades.**

I. MANUFACTURE.

2. The steel shall be made by the open-hearth process. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

3. The steel shall conform to the following requirements as to chemical composition: **Chemical Composition.**

		FLANGE.	FIREBOX.	
Carbon	For Plates ¾ in. or under in thickness	.....	0.12 – 0.25	per cent
	For Plates over ¾ in. in thickness	.....	0.12 – 0.30	"
Manganese		0.30 – 0.60	0.30 – 0.50	"
Phosphorus	Acid	not over 0.05	not over 0.04	"
	Basic	" " 0.04	" " 0.035	"
Sulfur		" " 0.05	" " 0.04	"
Copper		.....	" " 0.05	"

Ladle Analyses. 4. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of the elements specified in Section 3. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in Section 3.

Check Analyses. 5. An analysis may be made by the purchaser from a broken tension test specimen representing each plate as rolled. The chemical composition thus determined shall conform to the requirements specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests. 6. (*a*) The material shall conform to the following requirements as to tensile properties:

	FLANGE AND FIREBOX.
Tensile strength, lb. per sq. in.	55 000 – 65 000
Yield point, min., " "	0.5 tens. str.
Elongation in 8 in., min., per cent	$\frac{1\,500\,000}{\text{Tens. str.}}$
(See Section 7)	

(*b*) The yield point shall be determined by the drop of the beam of the testing-machine.

Modifications in Elongation. 7. (*a*) For material over $\frac{3}{4}$ in. in thickness, a deduction of 0.5 from the percentages of elongation specified in Section 6 (*a*) shall be made for each increase of $\frac{1}{8}$ in. in thickness above $\frac{3}{4}$ in., to a minimum of 20 per cent.

(*b*) For material $\frac{1}{4}$ in. or under in thickness, the elongation shall be measured on a gage length of 24 times the thickness of the specimen.

Bend Tests. 8. The test specimen shall bend cold through 180 deg. without cracking on the outside of the bent portion, as follows: For material 1 in. or under in thickness, around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 in. in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

Homogeneity Tests. 9. For firebox steel, a sample taken from a broken tension test specimen shall not show any single seam or cavity more than $\frac{1}{4}$ in. long, in either of the three fractures obtained in the test for homogeneity, which shall be made as follows:

The specimen shall be either nicked with a chisel or grooved on a machine, transversely, about $\frac{1}{16}$ in. deep, in three places about 2 in. apart. The first groove shall be made 2 in. from the square end; each succeeding groove shall be made on the opposite side from the preceding one. The specimen shall then be firmly held in a vise, with the first groove about $\frac{1}{4}$ in. above the jaws, and the projecting end broken off by light blows of a hammer, the bending being away from the groove. The specimen shall be broken at the other two grooves in the same manner. The object of this test is to open and render visible to the eye any seams due to failure to weld up or to interposed foreign matter, or any cavities due to gas bubbles in the ingot. One side of each fracture shall be examined and the lengths of the seams and cavities determined, a pocket lens being used if necessary.

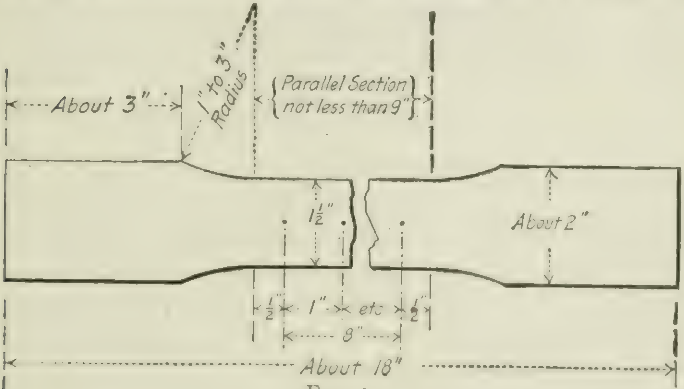

FIG. 1.

Test Specimens.

10. (*a*) Tension test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal test specimen shall be taken in the direction of the longitudinal axis of the ingot, and the transverse test specimen at right angles to that axis.

(*b*) Tension and bend test specimens shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

Number of Tests

11. (*a*) One tension and one bend test shall be made from each plate as rolled.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded and another specimen substituted.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 6 (*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS.

Permissible Variations. 12. *When Ordered to Thickness.*—The thickness of each plate shall not vary more than 0.01 in. under that ordered.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS.

Ordered Thickness, in.	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Expressed in Percentages of Nominal Weights.									Ordered Thickness, in.
	Under 48 in.	48 to 60 in., excl.	60 to 72 in., excl.	72 to 84 in., excl.	84 to 96 in., excl.	96 to 108in., excl.	108 to 120in., excl.	120 to 132in., excl.	132 in. or over.	
Under 1/8	9	10	12	14	..	..	..	..	..	Under 1/8
1/8 to 3/16 excl.	8	9	10	12	..	..	..	..	..	1/8 to 3/16 excl.
3/16 " 1/4 "	7	8	9	10	12	..	..	..	..	3/16 " 1/4 "
1/4 " 5/16 "	6	7	8	9	10	12	14	16	19	1/4 " 5/16 "
5/16 " 3/8 "	5	6	7	8	9	10	12	14	17	5/16 " 3/8 "
3/8 " 7/16 "	4.5	5	6	7	8	9	10	12	15	3/8 " 7/16 "
7/16 " 1/2 "	4	4.5	5	6	7	8	9	10	13	7/16 " 1/2 "
1/2 " 5/8 "	3.5	4	4.5	5	6	7	8	9	11	1/2 " 5/8 "
5/8 " 3/4 "	3	3.5	4	4.5	5	6	7	8	9	5/8 " 3/4 "
3/4 " 1 "	2.5	3	3.5	4	4.5	5	6	7	8	3/4 " 1 "
1 or over	2.5	2.5	3	3.5	4	4.5	5	6	7	1 or over

The overweight of each lot[1] in each shipment shall not exceed the amount given in Table I. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

V. FINISH.

Finish. 13. The finished material shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING.

Marking. 14. (*a*) The name or brand of the manufacturer, melt or slab number, grade, and lowest tensile strength for its grade specified in Section 6 (*a*), shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen.

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[1] The term "lot" applied to Table I means all of the plates of each group width and group thickness.

(*b*) When specified on the order, plates shall be match-marked as defined in Paragraph (*c*) so that the test specimens representing them may be identified. When more than one plate is sheared from a single slab or ingot, each shall be match-marked so that they may all be identified with the test specimens representing them.

(*c*) Each match mark shall consist of two over-lapping circles each not less than $1\frac{1}{2}$ in. in diameter, placed upon the shear lines, and made by separate impressions of a single-circle steel die.

(*d*) Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted.

VII. INSPECTION AND REJECTION.

Inspection.

15. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection.

16. (*a*) Unless otherwise specified, any rejection based on tests made in accordance with Section 5, shall be reported within five working days from the receipt of samples.

(*b*) Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

Rehearing.

17. Samples tested in accordance with Section 5, which represent rejected material, shall be preserved for two weeks from date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS
FOR
THE ALLOY: COPPER, 88 PER CENT; TIN, 10 PER CENT; ZINC, 2 PER CENT.

Serial Designation: B 10 – 15 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York, N. Y.

Basis of Purchase.

1. (*a*) These specifications cover the alloy commercially known as government bronze, admiralty gun-metal, gun-metal, or 88–10–2 mixture, when used in castings.

(*b*) It is recommended that this alloy shall not be used where castings are subjected to a temperature exceeding 260° C. (500° F.).

I. MANUFACTURE.

Process.

2. The alloy may be made by any approved method.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition.

3. The alloy shall conform to the following requirements as to chemical composition:

Copper	86–89	per cent.
Tin	8–11	"
Zinc	1– 3	"

Sampling.

4. (*a*) The sample for chemical analysis may be taken either by sawing, drilling or milling the casting or tension test specimen and shall represent the average cross-section of the piece.

(*b*) The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation and the saw dust or metal chips shall be carefully treated with a magnet to remove any particles of iron derived from the tools.

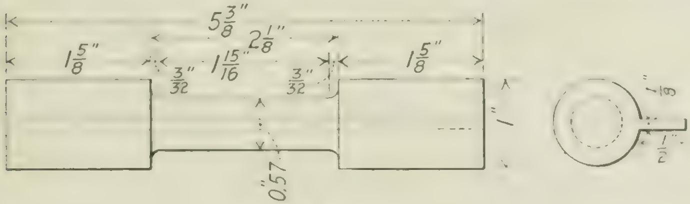

FIG. 1.

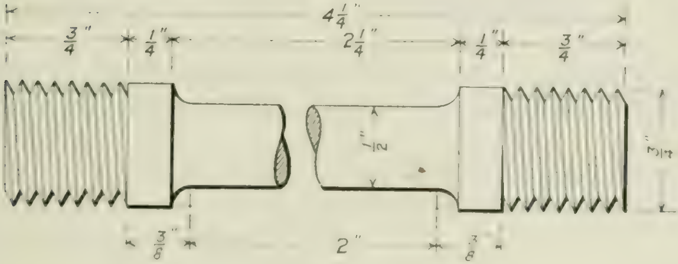

FIG. 2.

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. The alloy shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	33 000
Elongation in 2 in., per cent	14

Test Specimens.

6. (*a*) Two test bars of the form and dimensions shown in Fig. 1 shall be an integral part of large castings, or cast separately in the case of small castings to represent a lot or melt and shall be molded in a manner similar to the castings which they represent. If the castings are heat-treated, the test bars representing such castings shall be similarly heat-treated

(*b*) The manufacturer and purchaser shall agree whether test bars can be attached to castings, on the location of the bars on the castings, on the castings to which bars are to be attached, and on the method of casting unattached bars. Unless otherwise agreed upon, the minimum lot shall be considered as 500 lb.

(*c*) The tension test specimen, turned down from the test bar shown in Fig. 1, shall be of the form and dimensions shown in Fig. 2.

Number of Tests.

7. (*a*) Two tension tests shall be made from each lot or melt.

(*b*) If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another specimen in its stead.

IV. INVESTIGATION OF CLAIMS.

Investigation of Claims.

8. If the purchaser's tests show that the material does not conform to the requirements specified in Section 3, the manufacturer shall have the opportunity to inspect the material and each party shall select a sample for retest. If the results do not agree, they shall select the sample to be sent to a mutually agreeable umpire, whose decision shall be final. The costs of retests shall be paid by the loser.

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TENTATIVE SPECIFICATIONS
FOR
COPPER PLATES FOR LOCOMOTIVE FIREBOXES.

Serial Designation: B 11 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York, N. Y.

1. These specifications cover two grades of copper for locomotive fireboxes, namely, Arsenical and Non-Arsenical. **Grades.**

I. MANUFACTURE.

2. The copper shall be fire-refined or electrolytic, and hot rolled from suitable cakes. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

3. The copper shall conform to the following requirements as to chemical composition: **Chemical Composition.**

(*a*) *Arsenical Copper.*—Arsenical copper shall contain 0.25 to 0.50 per cent of arsenic, and shall not contain more than 0.120 per cent of impurities, exclusive of arsenic and silver.

(*b*) *Non-Arsenical Copper.*—Non-Arsenical copper shall have a purity of at least 99.880 per cent, as determined by electrolytic assay, silver being counted as copper. The total of impurities other than silver shall not exceed 0.120 per cent.

4. Analyses may be made by the purchaser from a broken tension test specimen representing each plate as rolled, which shall conform to the requirements specified in Section 3. **Chemical Analyses.**

III. PHYSICAL PROPERTIES AND TESTS.

Tension Tests.

5. The material shall conform to the following requirements as to tensile properties:

	ARSENICAL.	NON-ARSENICAL.
Tensile strength, lb. per sq. in.	not under 31 000	not under 30 000
Elongation in 8 in., min., per cent.	35	30

Bend Tests.

6. The specimen shall bend both hot (500 to 700° C.) and cold 180 deg. without cracking on the outside of the bent portion as follows: For material 1 in. or under in thickness, flat on itself; and for material over 1 in. in thickness, around a pin the diameter of which is equal to the thickness of the specimen.

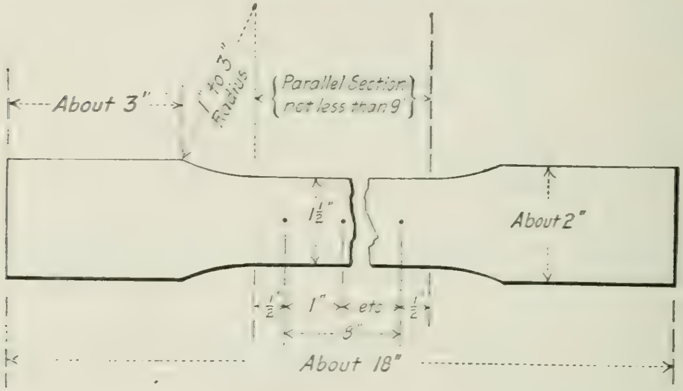

FIG. 1.

Test Specimens.

7. Tension and bend test specimens shall be taken from the finished rolled material. They shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. 1; except that bend test specimens may be machined with both edges parallel.

Number of Tests.

8. (*a*) One tension, one cold-bend and one hot-bend test shall be made from each plate as rolled.

(*b*) If any test specimen develops flaws it may be discarded and two other specimens substituted, both of which shall be free from flaws. If flaws appear in either or both of the substituted specimens the lot shall be rejected.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5 and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

(d) If any test specimen shows defective machining it may be discarded and another specimen substituted.

IV. PERMISSIBLE VARIATIONS IN WEIGHT AND THICKNESS.

Permissible Variations.

9. *When Ordered to Thickness.*—The thickness of each plate shall not vary more than 0.04 in. under that ordered. An excess over the nominal weight corresponding to the dimensions on the order shall be allowed for each plate if not more than that shown in Table I, one cubic inch of rolled copper being assumed to weight 0.323 lb.

TABLE I.—PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS.

ORDERED THICKNESS, IN.	WEIGHT, LB. PER SQ. FT.	PERMISSIBLE EXCESS IN AVERAGE WEIGHTS PER SQUARE FOOT OF PLATES FOR WIDTHS GIVEN, Expressed in Percentages of Nominal Weights.			
		Under 75 in.	75 to 100 in., excl.	100 to 115 in., excl.	115 in. or over.
$\frac{5}{16}$	14.53	8	12	16	..
$\frac{3}{8}$	17.44	7	10	13	17
$\frac{7}{16}$	20.34	6	8	10	13
$\frac{1}{2}$	23.25	5	7	9	12
$\frac{9}{16}$	26.16	5	6.5	8.5	11
$\frac{5}{8}$	29.06	5	6	8	10
Over $\frac{5}{8}$		5	5	6.5	9

V. FINISH.

Finish.

10. The finished material shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING.

Marking.

11. The name or brand of the manufacturer, plate number, and grade shall be stamped on each plate. The plate number shall be legibly stamped on each test specimen.

VII. INSPECTION AND REJECTION.

Inspection. 12. The manufacturer shall afford the inspector free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 13. (*a*) Unless otherwise specified, any rejection based on chemical and physical tests made in accordance with these specifications shall be reported within five working days from the receipt of samples.

(*b*) Material which, subsequent to its acceptance at the manufacturer's works, is shown to have contained injurious defects will be rejected, and the manufacturer shall be notified.

Rehearing. 14. Samples tested in accordance with Section 4, which represent rejected material, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

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TENTATIVE SPECIFICATIONS
FOR
COPPER BARS FOR LOCOMOTIVE STAYBOLTS.

Serial Designation: B 12 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York, N. Y.

1. These specifications cover two grades of copper for locomotive staybolts, namely, Arsenical and Non-Arsenical. **Grades.**

I. MANUFACTURE.

2. The copper shall be fire-refined or electrolytic and shall be finished to dimensions by hot rolling from suitable bars. **Process.**

II. CHEMICAL PROPERTIES AND TESTS.

3. The copper shall conform to the following requirements as to chemical composition: **Chemical Composition.**

(*a*) *Arsenical Copper.*—Arsenical copper shall contain 0.25 to 0.50 per cent of arsenic, and shall contain not more than 0.120 per cent of impurities exclusive of arsenic and silver.

(*b*) *Non-Arsenical Copper.*—Non-Arsenical copper shall have a purity of at least 99.880 per cent, as determined by electrolytic assay, silver being counted as copper. The total of impurities other than silver shall not exceed 0.120 per cent.

hemical nalyses. 4. An analysis may be made from one sample for each 5000 lb. or fraction thereof of finished bars, and such analyses shall conform to the requirements specified in Section 3.

III. PHYSICAL PROPERTIES AND TESTS.

ension Tests. 5. The material shall conform to the following requirements as to tensile properties:

	ARSENICAL.	NON-ARSENICAL.
Tensile strength, lb. per sq. in..........	not under 31 000	not under 30 000
Elongation in 8 in., min., per cent......	35	30

end Tests. 6. The test specimen shall bend cold through 180 deg. flat on itself without cracking on the outside of the bent portion.

est Specimens. 7. Bend test specimens shall be of the full-size section of bars as rolled.

umber of Tests. 8. (*a*) One tension and one bend test shall be made from each 5000 lbs. (or fraction).

(*b*) If any test specimen develops flaws it may be discarded and two other specimens substituted, both of which shall be free from flaws. If flaws appear in either or both of the substituted specimens the lot shall be rejected.

(*c*) If the percentage of elongation of any tension test specimen is less than that specified in Section 5, and any part of the fracture is outside the middle third of gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

(*d*) If any test specimen shows defective machining it may be discarded and another specimen substituted.

IV. PERMISSIBLE VARIATION IN GAGE.

ermissible ariations. 9. The bars shall be truly round within 0.01 in., and shall not vary more than 0.005 in. over nor more than 0.01 in. under the specified size.

V. WORKMANSHIP AND FINISH.

inish. 10. The finished bars shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING.

11. The finished bars shall, when loaded for shipment, be properly separated and marked with the name or brand of the manufacturer and the lot number for identification. The lot number shall be legibly marked on each test specimen. **Marking.**

VII. INSPECTION AND REJECTION.

12. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the bars are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

13. (*a*) Unless otherwise specified, any rejection based on chemical or physical tests made in accordance with these specifications shall be reported within five working days from the receipt of samples. **Rejection.**

(*b*) Bars which, subsequent to their acceptance at the manufacturer's works, are shown to have contained injurious defects will be rejected, and the manufacturer shall be notified.

14. Samples tested in accordance with Section 4, which represent rejected bars, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

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TENTATIVE SPECIFICATIONS
FOR
SEAMLESS COPPER BOILER TUBES.

Serial Designation: B 13 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York, N. Y.

Grades. 1. These specifications cover two grades of copper tubes for locomotive boilers, namely, Arsenical and Non-Arsenical.

I. MANUFACTURE.

Process. 2. The copper shall be fire-refined or electrolytic and shall be made into tubes, either by the hot-rolling or cold-drawing process. It shall be finished by cold drawing.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The copper shall conform to the following requirements as to chemical composition:

(*a*) *Arsenical Copper.*—Arsenical copper shall contain from 0.15 to 0.35 per cent of arsenic, and shall not contain more than 0.120 per cent of impurities, exclusive of arsenic and silver.

(*b*) *Non-Arsenical Copper.*—Non-Arsenical copper shall have a purity of at least 99.880 per cent, as determined by electrolytic assay, silver being counted as copper. The total of impurities other than silver shall not exceed 0.120 per cent.

Chemical Analyses.

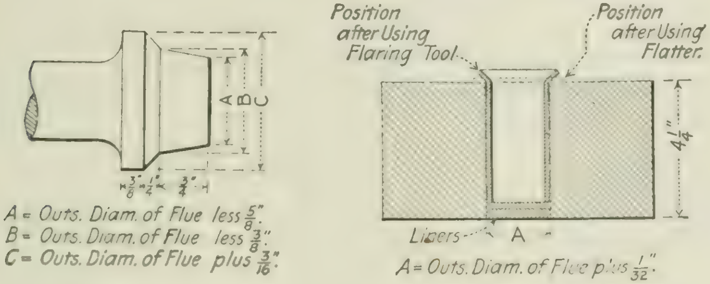
4. (*a*) Analyses of two tubes in each lot of 250 or less may be made by the purchaser, which shall conform to the requirements specified in Section 3. Drillings for analyses shall be taken from several points around each tube, or turnings may be taken from the end of the tube.

(*b*) If the analysis of any one tube does not conform to the requirements specified in Section 3, analyses of two additional tubes of the same lot shall be made, each of which shall conform to the requirements specified.

III. PHYSICAL PROPERTIES AND TESTS.

Temper.

5. Tubes will be furnished hard or annealed, as specified. Test specimens taken from hard tubes shall be annealed before testing.


A B C
3/8" 1/4" 3/4"
A = Outs. Diam. of Flue less 5/8".
B = Outs. Diam. of Flue less 3/8".
C = Outs. Diam. of Flue plus 3/16".
Position after Using Flaring Tool
Position after Using Flatter.
4 1/4"
Liners
A
A = Outs. Diam. of Flue plus 1/32".

Flaring Tool. Die Block.

FIG. 1.

Flange Tests.

6. (*a*) A test specimen not more than 4 in. in length shall have a flange turned over at right angles to the body of the tube, without showing cracks or flaws. This flange, as measured from the outside of the tube, shall be $\frac{3}{8}$ in. wide for tubes $2\frac{1}{2}$ in. or under in outside diameter, and $\frac{1}{2}$ in. wide for tubes over $2\frac{1}{2}$ in. in outside diameter.

(*b*) In making the flange test, it is recommended that the flaring tool and die block shown in Fig. 1 be used.

Crush Test.

7. A test specimen $2\frac{1}{2}$ in. in length shall stand crushing longitudinally until the outside folds are in contact, without showing cracks or flaws.

Hydrostatic Test.

8. All tubes shall stand an internal hydrostatic pressure of

750 lb. per sq. in. The hydrostatic pressure test shall be applied to the finished tubes before annealing.

Test Specimens.

9. (*a*) Test specimens shall consist of sections cut from tubes selected by the inspector representing the purchaser from the lot offered for shipment. They shall be smooth on the ends and free from burrs.

(*b*) All specimens shall be tested cold.

Number of Tests.

10. One flange and one crush test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test.

11. If the results of the physical tests of only one tube from any lot do not conform to the requirements specified, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

IV. STANDARD WEIGHTS.

Standard Weights.

12. The standards weights for tubes of various outside diameters and thickness are as follows:

THICKNESS.		WEIGHT, LB. PER FT. OF LENGTH, Outside Diameter, in.				
In.	B. w. g.	1½	1¾	2	2¼	½
0.095	13	1.624	1.913	2.202	2.491	2.779
0.109	12	1.844	2.176	2.507	2.839	3.170
0.120	11	2.015	2.380	2.744	3.109	3.474
0.134	10	2.227	2.634	3.042	3.449	3.857
0.148	9	2.434	2.884	3.334	3.785	4.235

Permissible Variations.

13. The weight of the tubes shall not vary more than 5 per cent from that specified in Section 12.

V. WORKMANSHIP AND FINISH.

Workmanship.

14. The finished tubes shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. The thickness at any point shall not vary more than 10 per cent from that specified. The length shall not be under, but may be 0.125 in. over that ordered.

15. The finished tubes shall be free from injurious defects and shall have a workmanlike finish. They shall be straight, free from kinks, bends and buckles. **Finish.**

VI. MARKING.

16. The name or brand of the manufacturer, and "tested at 750 lb." shall be legibly stenciled on each tube. **Marking.**

VII. INSPECTION AND REJECTION.

17. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tubes are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works. **Inspection.**

18. (*a*) Unless otherwise specified, any rejection based on chemical or physical tests made in accordance with these specifications shall be reported within five working days from the receipt of samples. **Rejection.**

(*b*) Tubes when inserted in the boiler shall stand expanding and bending without showing cracks or flaws. Tubes which fail in this manner will be rejected, and the manufacturer shall be notified.

19. Samples tested in accordance with Section 4, which represent rejected tubes, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time. **Rehearing.**

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TENTATIVE SPECIFICATIONS

FOR

SEAMLESS BRASS BOILER TUBES.

Serial Designation: B 14 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. William Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York, N. Y.

1. These specifications cover brass tubes for locomotive boilers.

I. MANUFACTURE.

Process. 2. The tubes shall be cold drawn to size and semi-annealed. They shall be fully annealed at both ends, if so ordered.

II. CHEMICAL PROPERTIES AND TESTS.

Chemical Composition. 3. The material shall conform to the following requirements as to chemical composition:

70 AND 30 ALLOY.

Copper	Not under	69.00	per cent
Lead	Not over	0.50	"
Iron	Not over	0.10	"
Materials other than copper and zinc	Not over	0.50	"

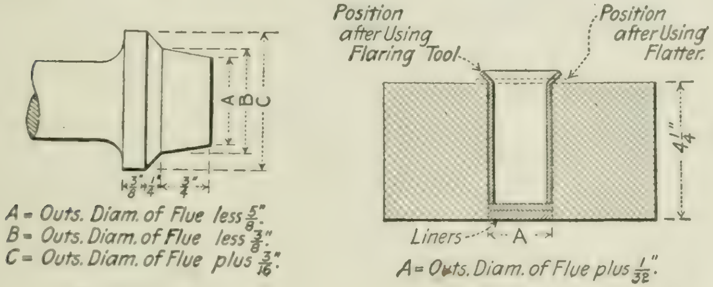
Chemical Analyses. 4. (*a*) Analyses of two tubes in each lot of 250 or less may be made by the purchaser, which shall conform to the requirements specified in Section 3. Drillings or turnings may be taken from the end of the tube for analyses.

(*b*) If the analysis of any one tube does not conform to the requirements specified in Section 3, analyses of two additional tubes of the same lot shall be made, each of which shall conform to the requirements specified.

III. PHYSICAL PROPERTIES AND TESTS.

Temper. 5. Test specimens taken from semi-annealed tubes shall be fully annealed before testing.

Flange Test. 6. (*a*) A test specimen not more than 4 in. in length shall have a flange turned over at right angles to the body of the tube without showing cracks or flaws. The outside diameter of this flange shall measure not less than 1¼ times the original outside diameter of the tube.


A
B
C
3/8"
1/4"
3/4"
A = Outs. Diam. of Flue less 5/8".
B = Outs. Diam. of Flue less 3/8".
C = Outs. Diam. of Flue plus 3/16".
Position after Using Flaring Tool
Position after Using Flatter.
4¼"
Liners
A
A = Outs. Diam. of Flue plus 1/32".

Flaring Tool.

Die Block.

FIG. 1.

(*b*) In making the flange test, it is recommended that the flaring tool and die block shown in Fig. 1 be used.

Flattening and Doubling-Over Test. 7. The tubes shall be capable of standing the following test, when cold, without showing either crack or flaw: A piece of the tube shall be flattened down, until the interior surfaces of the tube meet, and then be doubled over on itself, that is, bent through an angle of 180 deg., the bend being at right angles to the direction of the length of the tube.

Hydrostatic Tests. 8. All tubes shall stand an internal hydrostatic pressure of at least 750 lb. per sq. in.

Test Specimens. 9. (*a*) Test specimens shall consist of sections cut from tubes selected by the inspector representing the purchaser from the lot offered for shipment. They shall be smooth on the ends and free from burrs.

(*b*) All specimens shall be tested cold.

Number of Tests. 10. One flange and one flattening test shall be made from each of two tubes in each lot of 250 or less. Each tube shall be subjected to the hydrostatic test.

11. If the results of the physical tests of only one tube from any lot do not conform to the requirements specified, retests of two additional tubes from the same lot shall be made, each of which shall conform to the requirements specified.

IV. STANDARD WEIGHTS.

Standard Weights. 12. The standard weights for tubes of various outside diameters and thickness are as follows:

THICKNESS.		WEIGHT, LB. PER FT. OF LENGTH, Outside Diameter, in.				
In.	B. w. g.	1½	1¾	2	2¼	2½
0.095	13	1.551	1.827	2.102	2.378	2.654
0.109	12	1.761	2.078	2.395	2.711	3.028
0.120	11	1.924	2.272	2.621	2.969	3.318
0.174	10	2.127	2.516	2.905	3.294	3.683
0.148	7	2.325	2.755	3.184	3.614	4.044

Permissible Variations. 13. The weight of the tubes shall not vary more than 5 per cent from that specified in Section 12.

V. WORKMANSHIP AND FINISH.

Workmanship. 14. The finished tubes shall be circular within 0.02 in. and the mean outside diameter shall not vary more than 0.015 in. from the size ordered. The thickness at any point shall not vary more than 10 per cent from that specified. The length shall not be under, but may be 0.125 in. over that ordered.

Finish. 15. The finished tube shall be free from injurious defects and shall have a workmanlike finish. It shall be straight, free from kinks, bends and buckles.

VI. MARKING.

Marking. 16. The name or brand of the manufacturer, and "tested at 750 lb." shall be legibly stenciled on each tube.

VII. INSPECTION AND REJECTION.

Inspection. 17. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the tubes are being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

Rejection. 18. (*a*) Unless otherwise specified, any rejection based on chemical and physical tests made in accordance with these specifications shall be reported within five working days from the receipt of samples.

(*b*) Tubes when inserted in the boiler shall stand expanding and bending without showing cracks or flaws. Tubes which fail in this manner will be rejected, and the manufacturer shall be notified.

Rehearing. 19. Samples tested in accordance with Section 4, which represent rejected tubes, shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE DEFINITIONS
OF
TERMS RELATING TO THE GYPSUM INDUSTRY.

Serial Designation: C 11 – 16 T.

Criticisms of these Tentative Definitions are solicited and should be directed to Mr. R. J. Wig, Chairman of Committee C-11 on Gypsum and Gypsum Products, Bureau of Standards, Washington, D. C.

SYNOPSIS.

These definitions are divided into fifteen parts, under the following titles:

I. GYPSUM: ITS FORMS, FUNCTIONS AND PRODUCTS.

Giving the various forms in which gypsum is used, its functions in the various classes of products, and a list of these products classified according to these functions.

II. CEMENTITIOUS BASE PRODUCTS.

A development of the products classified according to the first function given under Part I.

III–VII.

A skeleton outline of the development of products classified according to the remaining functions given under Part I.

VIII. CLASSES, TYPES AND FORMS OF CEMENTITIOUS BASE PRODUCTS.

A development of the classes, types and forms of the products given in

Part II. The plan is to give the definition of each product as it is listed, it being the intention that this arrangement will show the reason for the adoption of certain terms, and for the avoidance of other terms.

IX–XIII.

To be a development, similar to Part VIII, of the classes, types and forms of the products given in Parts III–VII.

XIV. GLOSSARY.

Contains a list of the ingredients used in gypsum products with their definitions, and a list of terms the use of which should be avoided if possible.

XV. APPENDIX.

Contains a discussion of the reasons for the adoption or avoidance of all of the foregoing terms.

I. GYPSUM: ITS FORMS, FUNCTIONS AND PRODUCTS.

(*A*) FORMS.

1. Gypsum is used in the arts in two forms: **Forms.**
    - (*a*) Uncalcined.
        - (1) Mass.
        - (2) Crushed.
        - (3) Ground.
    - (*b*) Calcined.

(*B*) FUNCTIONS.

2. Gypsum is used to function in several distinct ways: **Functions.**
    - (*a*) As a cementitious base.
    - (*b*) As a chemical.
    - (*c*) As a pigment.
    - (*d*) As a filler.
    - (*e*) As a flux.
    - (*f*) As a (other functions to follow).

(*C*) PRODUCTS.

3. Gypsum is mixed with other materials in the following classes of products: **Products.**
    - (*a*) As a cementitious base in
        - (1) Coatings—applied in plastic form.
        - (2) Bondings—applied in plastic form.

- (3) Structural products.
- (4) Cast products.
- (5) Pottery products.

(*b*) As a chemical in
- (1) Fertilizers.
- (2) Portland-cement manufacture.
- (3) Sulfuric-acid manufacture.
- (4) Brewing industry.

(*c*) As a pigment in
- (1) Paints, oil, or water.

(*d*) As a filler in
- (1) Paper.
- (2) Cloth.

(*e*) As a flux in
- (1) Brass melting.

(*f*) As a carrier for
- (1) Paris green.

II. CEMENTITIOUS BASE PRODUCTS.

(*A*) COATINGS.

Coatings. 4. Coatings applied in a plastic form are sub-divided as follows:

(*a*) *Plaster.*—A material used in a plastic state to form a hard covering for the *interior* surfaces, walls, ceilings, etc., of any building or structure. The word "plaster" is used without regard to the composition of the material, defining only its use and location of use as contrasted with the words "stucco" and "mortar."

For Gypsum Plaster, see Part VIII, Section 22 (*c*) *1*.

(*b*) *Stucco.*—A material used in a plastic state to form a hard covering for the *exterior* walls or other *exterior* surfaces of any building or structure. The word "stucco" is used without regard to the composition of the material, defining only its use and location of its use, as contrasted with the words "plaster" and "mortar."

For Gypsum Stucco, see Part VIII, Section 22 (*c*) *2*.

(*B*) BONDINGS.

5. Bondings applied in a plastic form are sub-divided as follows: **Bondings.**

(*a*) *Mortar.*—A material used in a plastic state, becoming hard in place, to bond together such materials as brick, stone, tile, gypsum blocks, terra cotta, etc., in building walls, partitions, columns, foundations, piers, floors, and roof arches, etc. The word "mortar" is used without regard to the composition of the material, defining its use as a bonding material, as contrasted with the words "stucco" and "plaster."

For Gypsum Mortar, see Part VIII (*B*)—(Definition to follow.)

(*C*) STRUCTURAL PRODUCTS.

6. Gypsum structural products are sub-divided as follows: **Structural Products.**
(Definitions to follow.)

(*a*) *Gypsum Plaster Boards.*
(*b*) *Gypsum Blocks* are sub-divided as follows:
  (1) Floor tile.
  (2) Book tile.
  (3) Roof tile.
  (4) Partition blocks.
  (5) Furring tile.
  (6) Column covering.
(*c*) *Concrete* is sub-divided as follows:
  (1) Arches—floor and roof.

(*D*) CAST PRODUCTS.

7. Gypsum cast products are sub-divided as follows: **Cast Products.**
(Definitions to follow.)

(*E*) POTTERY PRODUCTS.

Pottery Products.

8. Gypsum pottery products are sub-divided as follows:

(Definitions to follow.)

III. CHEMICAL PRODUCTS.

(*A*) FERTILIZERS.

Fertilizers.

9. Gypsum fertilizers are sub-divided as follows:

(Definitions to follow.)

(*B*) PORTLAND-CEMENT MANUFACTURE.

Portland-Cement Manufacture.

10. The uses of gypsum in Portland-cement manufacture may be sub-divided as follows:

(Definitions to follow.)

(*C*) SULFURIC-ACID MANUFACTURE.

Sulfuric-Acid Manufacture.

11. The uses of gypsum in sulfuric-acid manufacture may be sub-divided as follows:

(Definitions to follow.)

(*D*) (Title to follow.)

12. The uses of gypsum in (another chemical process) may be sub-divided as follows:

(Definitions to follow.)

IV. PIGMENT PRODUCTS.

(*A*) COATINGS APPLIED WITH BRUSH.

Coatings Applied with Brush.

13. Liquid gypsum coatings applied with a brush are sub-divided as follows:

(Definitions to follow.)

(*B*) (Title to follow.)

14. (Another pigment product) are sub-divided as follows:

(Definitions to follow.)

V. FILLER PRODUCTS.

(*A*) PAPER FILLERS.

15. Gypsum paper fillers are sub-divided as follows: **Paper Fillers.**

(Definitions to follow.)

(*B*) CLOTH FILLERS.

16. Gypsum cloth fillers are sub-divided as follows: **Cloth Fillers.**

(Definitions to follow.)

(*C*) (Title to follow.)

17. Gypsum (other fillers) are sub-divided as follows:

(Definitions to follow.)

VI. FLUX PRODUCTS.

(*A*) FOUNDRY-CORE FLUXES.

18. Gypsum foundry-core fluxes are sub-divided as follows: **Foundry-Core Fluxes.**

(Definitions to follow.)

(*B*) (Title to follow.)

19. Gypsum (other fluxes) are sub-divided as follows:

(Definitions to follow.)

VII. (Other) PRODUCTS.

(*A*) (Title to follow.)

20. Gypsum (other products) are sub-divided as follows:

(Definitions to follow.)

(*B*) (Title to follow.)

21. Gypsum (other products) are sub-divided as follows:

(Definitions to follow.)

VIII. CLASSES, TYPES AND FORMS OF CEMENTITIOUS BASE PRODUCTS.

(*A*) COATINGS.

Classes of Coatings.

22. *Classes.*—Gypsum coatings applied in plastic form (plasters and stuccoes) are divided into several classes depending upon the predominating cementitious material, as follows:

(*a*) *Lump-Lime Plaster and Stucco.*

1. *Lump-Lime Plaster.*—A plaster in which the predominating cementitious material is lime putty made by slaking quicklime at the job.
2. *Lump-Lime Stucco.*—A stucco in which the predominating cementitious material is lime putty made by slaking quicklime at the job.

(*b*) *Hydrated-Lime Plaster and Stucco.*

1. *Hydrated-Lime Plaster.*—A plaster in which the predominating cementitious material is hydrated lime. It may be either "job-mixed plaster" or "prepared plaster." (See Section 23.)
2. *Hydrated-Lime Stucco.*—A stucco in which the predominating cementitious material is hydrated lime. It may be either "job-mixed stucco" or "prepared stucco." (See Section 23 (*a*)*2*, or (*b*)*2*.)

(*c*) *Gypsum Plaster and Stucco.*

1. *Gypsum Plaster.*—A plaster in which the predominating cementitious material is calcined gypsum.

   (Frequently called "cement plaster," "hard wall plaster," "patent plaster," "calcined plaster," "rock-wall plaster," "stucco wall plaster," etc. The use of these terms should be avoided.)

2. *Gypsum Stucco.*—A stucco in which the predominating cementitious material is calcined gypsum.

(*d*) *Keene's-Cement Plaster and Stucco.*

1. *Keene's-Cement Plaster.*—A plaster in which the predominating cementitious material is Keene's cement.
2. *Keene's-Cement Stucco.*—A stucco in which the predominating cementitious material is Keene's cement.

(*e*) *Portland-Cement Plaster and Stucco.*

1. *Portland-Cement Plaster.*—A plaster in which the predominating cementitious material is Portland cement.
2. *Portland-Cement Stucco.*—A stucco in which the predominating cementitious material is Portland cement.

(*f*) *Natural-Cement Plaster and Stucco.*

1. *Natural-Cement Plaster.*—A plaster in which the predominating cementitious material is natural cement.
2. *Natural-Cement Stucco.*—A stucco in which the predominating cementitious material is natural cement.

Forms of Coatings.

23. *Forms.*—Plasters and stuccoes are divided into several forms depending upon the amount of mixing done at the mill of the producer as follows:

(*a*) *Job-Mixed Plaster and Stucco.*

1. *Job-Mixed Plaster.*—A plaster in which all the ingredients are mixed at the job.
2. *Job-Mixed Stucco.*—A stucco in which all the ingredients are mixed at the job.

(*b*) *Prepared Plaster and Stucco.*

1. *Prepared Plaster.*—A plastering material mixed at the mill by the producer with all the constituent parts in their proper proportion, with the exception of the aggregate which may or may not be incorporated with the mixture at the mill.

   Prepared plasters are sub-divided into "ready-mixed plasters" and "neat plasters." See definition of these plasters.

2. *Prepared Stucco.*—A stucco material mixed at the mill by the producer with all the constituent parts in their proper proportion, with the exception of the aggregate which may or may not be incorporated with the mixture at the mill.

   Prepared stuccoes are sub-divided into "ready mixed stucco" and "neat stuccoes." See definitions of these stuccoes.

3. *Ready-Mixed Plaster.*—A "prepared plaster" requiring only the addition of water to make it ready for use.

   This term distinguishes "ready-mixed plaster" from "neat plaster."

4. *Ready-Mixed Stucco.*—A "prepared stucco" requiring only the addition of water to make it ready for use.

   This term distinguishes "ready-mixed stucco" from "neat stucco."

5. *Neat Plaster.*—A "prepared plaster" requiring the addition of both the aggregate and water to make it ready for use.

   This term distinguishes "neat plaster" from "ready-mixed plaster."

6. *Neat Stucco.*—A "prepared stucco" requiring the addition of both the aggregate and water to make it ready for use.

   This term distinguishes "neat stucco" from "ready-mixed stucco."

Types of Coatings. 24. *Types.*—Plasters and stuccoes are divided into several types depending upon the following conditions:

(*a*) *Material Used as an Aggregate.*

1. *Sand Plaster and Sand Stucco.*

   Sand Plaster.—A plaster in which sand is used as the aggregate. This expression is used without regard to either the cementitious material employed, or the place of mixing the ingredients.

   This term distinguishes "sand plaster" from "pulp plaster."

   Sand Stucco.—A stucco in which sand is used as the aggregate. This expression is used without regard to either the cementitious material employed, or the place of mixing the ingredients.

   This term distinguishes "sand stucco" from "pulp stucco."

2. *Pulp Plaster and Pulp Stucco.*

   Pulp Plaster.—A plaster in which pulp is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

This expression distinguishes "pulp plaster" from "sand plaster."

Pulp Stucco.—A stucco in which pulp is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

This expression distinguishes "pulp stucco" from "sand stucco."

3. *Fiber Plaster and Fiber Stucco.*

Fiber Plaster.—A plaster in which fiber is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

Fiber Stucco.—A stucco in which fiber is used as the aggregate. This expression is used without regard to either the cementitious material employed or the place of mixing the ingredients.

(*b*) *Number of Coats.*

1. *Two-Coat Work.* (Definition to follow.)
2. *Three-Coat Work.* (Definition to follow.)

First or Scratch Coat.—The first coat of plaster or stucco. It is applied directly to the lath or masonry surfaces to be covered, and is scratched before thoroughly dry to provide a better bond for the next coat.

Second or Browning Coat.—The second coat of plaster or stucco. Generally used only in three-coat work, but does sometimes mean the finishing coat in two-coat work.

(*c*) *Method of Application.*

1. *Dry Scratch Work.* (Definition to follow.)
2. *Doubled-up Work.* (Definition to follow.)
3. *Drawn Work.* (Definition to follow.)

(*d*) *Finish.*—The finish given to a plastered or stuccoed surface is sub-divided as follows:

Finish or White Coat.—The last coat of plaster or stucco. In three-coat work it is applied to the second coat, and in two-coat work it is applied to the first coat, and then sometimes known as the second coat.

1. *White Troweled or Smooth Finish.* (Definition to follow.)
2. *Sand-Float or Rough Finish.* (Definition to follow.)
3. *Pebble Dash Finish.* (Definition to follow.)
4. *Stippled Finish.* (Definition to follow.)

(*B*) BONDINGS.

Development of Part II (*B*), Section 5. Definitions to follow.

(*C*) STRUCTURAL PRODUCTS.

Development of Part II (*C*), Section 6. Definitions to follow.

(*D*) CAST PRODUCTS.

Development of Part II (*D*), Section 7. Definitions to follow.

(*E*) POTTERY PRODUCTS.

Development of Part II (*E*), Section 8. Definitions to follow.

IX. CLASSES, TYPES AND FORMS OF CHEMICAL PRODUCTS.

Development of Part III, Sections 9–12. Definitions to follow.

X. CLASSES, TYPES AND FORMS OF PIGMENT PRODUCTS.

Development of Part IV, Sections 13–14. Definitions to follow.

XI. CLASSES, TYPES AND FORMS OF FILLER PRODUCTS.

Development of Part V, Sections 15–17. Definitions to follow.

XII. CLASSES, TYPES AND FORMS OF FLUX PRODUCTS.

Development of Part VI, Sections 18–19. Definitions to follow.

XIII. CLASSES, TYPES AND FORMS OF (Other) PRODUCTS.

Development of Part VII, Sections 20–21. Definitions to follow.

XIV. GLOSSARY.

(*A*) DEFINITIONS OF INGREDIENTS OF GYPSUM PRODUCTS.

1. *Gypsum.*—Gypsum is a hydrous calcium sulfate, formula $CaSO_4.2H_2O$, which may contain varying percentages of silica, alumina, iron oxide, and carbonates of calcium and magnesium.

   Limitations as to percentages of impurities should be established.

2. *Uncalcined Gypsum.*—A synonym for gypsum.

   Generally used to mean the raw material as taken from the mine or quarry for commercial use.

3. *Mass Gypsum.*—(Definition to follow.)
4. *Crushed Gypsum.*—A form of uncalcined gypsum. The size (state size limitations), distinguishing it from "ground gypsum."
5. *Ground Gypsum.*—A form of uncalcined gypsum. The size (state size limitations), distinguishing it from "crushed gypsum."
6. *Calcined Gypsum.*—A product resulting from the partial or complete calcination of gypsum. A cementitious material often used in stuccoes, plasters, mortars, concretes, etc., as the active setting material.

   Chemically pure calcined gypsum has the formula $CaSO_4.H_2O$. The commercial material has the same impurities as gypsum; silica, alumina, iron oxide, and carbonates of calcium and magnesium. Limitations as to percentage of impurities should be established. Frequently called "Plaster of Paris," the use of which should be avoided. (See Part XIV, Glossary, Section 29.)

7. *Cement.*—A material or a mixture of materials having cementitious properties (as hydrated lime, Portland cement, calcined gypsum, natural cement, glue, asphalt, Keene's cement, etc.). The word "cement" is used without regard to the composition of the material, and does not define its use or location of use as do the words "stucco," "plaster" and "mortar."

8. *Concrete.*—A mixture of one or more cementitious materials (as Portland cement, hydrated lime, calcined gypsum, natural cement, etc.), with an aggregate of sand, broken stone, cinders, asbestos fiber, etc., which becomes a solid mass when the cementitious materials have hardened.

9. *Portland Cement.*—The product obtained by finely pulverizing clinker produced by calcining to incipient fusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

Definition taken from Standard Specifications for Cement (Serial Designation: C 9) of the American Society for Testing Materials.[1]

10. *Natural Cement.*—The finely pulverized product resulting from the calcination of an argillaceous limestone at a temperature only sufficient to drive off the caronbic acid gas.

Definition taken from Standard Specifications for Cement (Serial Designation: C 10) of the American Society for Testing Materials.[1]

11. *Keene's Cement.*—(Definition to follow.)

12. *Quicklime.*—A material the major part of which is calcium oxide or calcium and magnesium oxide, which will slake on the addition of water.

Definition taken from Standard Specifications for Quicklime (Serial Designation: C 5) of the American Society for Testing Materials,[1] where it is divided into two forms, "lump" and "pulverized." See definitions of "lump lime" and "pulverized lime."

Also known as "lime," "lump lime," "burned lime," "calcined lime," the use of which terms should be avoided.

13. *Lump Lime.*—A form of quicklime. The size taken from the kiln without crushing or grinding, distinguishing it from "pulverized lime."

Definition taken from Standard Specifications for Quicklime (Serial Designation: C 5) of the American Society for Testing Materials.[1] The form of quicklime generally slaked at the job tc make "lime putty."

14. *Pulverized Lime*—A form of quicklime; "lump lime" reduced in size to pass a $\frac{1}{4}$-in. screen, distinguishing it from "lump lime."

Definition taken from Standard Specifications for Quicklime

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[1] See 1916 Volume of A.S.T.M. Standards.—ED.

(Serial Designation: C 5) of the American Society for Testing Materials.[1] This form of quicklime is seldom slaked at the job to produce "lime putty."

15. *Hydrated Lime.*—A cementitious material often used in stucco, plaster, mortar, etc., as an active setting agent. Always prepared at the mill of the producer and never made at the job from quicklime.

The definition given in the Standard Specifications for Hydrated Lime (Serial Designation: C 6) of the American Society for Testing Materials[1] is as follows: "A dry flocculent powder resulting from the hydration of quicklime." Analysis required by these specifications permits only the amount of water necessary to satisfy chemical hydration. This makes production of hydrated lime impossible at the job.

16. *Lime Putty.*—The predominating cementitious material in lime plaster, lime stucco and lime mortar. Made by slaking "quicklime" with an excess of water, or by adding water to "hydrated lime." A white, cream-like, smooth plastic paste.

Also called "slaked lime," the use of which term should be avoided.

17. *Lime Paste.*—A synonym of "lime putty."

18. *Aggregate.*—The inert materials used as a filler in stucco, plaster, mortar, concrete mixtures, without regard to their function as a binding material.

19. *Fine Aggregate.*—(Definition to follow.)

20. *Filler.*—A synonym for "aggregate."

21. *Sand.*—(Definition to follow.)

22. *Pulp.*—A binder used in stucco and plaster. Made by grinding, crushing or shredding wood in a manner similar to that in preparing wood pulp in paper manufacture. One of the general classes of fiber binders.

23. *Binder.*—A material used in stucco and plaster to increase the tensile strength, intended to prevent cracking and crumbling.

24. *Fiber.*—A general class of material used as binders in stucco and plaster. May be of wood, asbestos, hemp, etc.

25. *Hair.*—A binder used in stucco and plaster. Obtained from goats, cattle or other animals. One of the general class of fiber binders.

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[1] See 1916 Volume of A.S.T.M. Standards.—ED.

26. *Asbestos.*—(Definition to follow.)
27. *Retarders.*—Any material used in stucco, plaster, mortar, concrete, etc., to reduce the rapidity with which the cementitious materials set.
28. *Accelerators.*—Any material used in stucco, plaster, mortar, concrete, etc., to increase the rapidity with which the cementitious materials set.

(*B*) TERMS, THE USE OF WHICH SHOULD BE AVOIDED IF POSSIBLE.

29. *Plaster-of-Paris.*—This term uses "plaster" in a sense not in agreement with the definition. Also, this material is wrongly considered to be plaster, resulting in misunderstandings. "Calcined gypsum" is the term that should be used. (See Part XIV, Glossary, Section 6.)
30. *Cement Plaster.*—The term lacks definiteness, as it has been used to mean both "gypsum plaster" and "Portland-cement plaster."
31. *Hard Wall Plaster.*—See Part XV, Appendix, Section 20.
32. *Rock Wall Plaster.*—See Part XV, Appendix, Section 20.
33. *Patent Plaster.*—See Part XV, Appendix, Section 20.
34. *Calcined Plaster.*—See Part XV, Appendix, Section 20.
35. *Stucco Plaster.*—See Part XV, Appendix, Section 20.
36. *Wall Plaster.*—See Part XV, Appendix, Section 20.
37. *Stucco Wall Plaster.*—See Part XV, Appendix, Section 20.
38. *Ceiling Plaster.*—See Part XV, Appendix, Section 20.
39. *Dry Mortar..*
40. *Bag Mortar.*
41. *Plaster Mortar.*
42. *Stucco Mortar.*
43. *Lime.*—It has been misused to mean any cementitious lime material without regard to its chemical or physical nature, and now lacks specific meaning. Chemically pure lime (CaO) is seldom used in the arts. See definition of "quicklime."
44. *Burned Lime.*—See definition of "quicklime," Part XIV, Glossary, Section 12.
45. *Calcined Lime.*—See definition of "quicklime," Part XIV, Glossary, Section 12.
46. *Slaked Lime.*—See definition of "lime putty" or "lime paste," Part XIV, Glossary, Sections 16 or 17.
47. *Building Lime.*—See definition of "quicklime," "lump lime," "pulverized lime," "hydrated lime," Part XIV, Glossary, Sections 12–15.
48. *Land Plaster.*

APPENDIX.

XV. DEVELOPMENT OF DEFINITIONS.

(*A*) Stucco.

1. The word "stucco" is derived from the old High German word "stuchhi" meaning "a crust" or "piece." **Stucco.**

2. Webster's Unabridged Dictionary defines the "stucco" as "plaster of any kind used as a coating for walls; especially a fine plaster, composed of lime or gypsum, sand and pounded marble, used for internal decorations and fine work." From this it appears that "stucco" may mean a coating for either exterior or interior walls, with particular reference to interior ornamental work as moldings, cornices, etc.

3. Manufacturers have used the word stucco to mean different materials without regard to the location of the surface to which it is applied. The following shows how "stucco" has been used by various manufacturers.

(*a*) Atlas Wall Plaster Co., Louisville, Ky., produce "Atlas Stucco Finish" for interior finish only, which is a calcined gypsum product.

(*b*) Michigan Gypsum Co., Grand Rapids, Mich., produce "N. P. Brand Stucco" for interior finish only, which is a calcined gypsum product.

(*c*) Plymouth Gypsum Co., Fort Dodge, Iowa, produce "Plymouth Rock Stucco," use not given, but probably for *exterior* work; which is a calcined gypsum product.

(*d*) The Associated Metal Lath Manufacturers have defined "stucco" as referring solely to a covering of an exterior wall without regard to the composition of the material.

(*e*) Monument Plaster Co., Harrison, N. J., produce "Oriental Stucco," a material for exterior finish only. This is a lime product.

(*f*) The Association of American Portland Cement Manufacturers have prepared Bulletin No. 22 on Portland-Cement Stucco. In this Bulletin "stucco" is used to mean a covering of an exterior wall only.

4. An examination of other literature in which the word "stucco" is used shows the following:

(*a*) Mr. Edwin C. Eckel, C.E., in his book on "Cements, Limes and Plasters" considers "stucco" as a synonym for Plaster of Paris without definition as to its use in exterior or interior work

(*b*) Many books describing exterior treatments for buildings by applying coatings of cementitious materials, use the word "stucco" in describing the materials.

(*c*) The paint manufacturers that produce materials for coloring, dampproofing and weatherproofing stucco use the word "stucco" to mean the material used to coat an exterior wall.

(*d*) Among architects, building contractors, and building owners, the word "stucco" has grown to mean an exterior wall covering or coating.

5. Consequently, it is advisable to discontinue the use of the word "stucco" to describe a covering material for an interior surface; since, where the greatest study of the materials for exterior surface covering has been made, "stucco" has been used to differentiate this use of material from all others.

(*B*) PLASTER.

Plaster. 6. The word "plaster" is derived from the Greek and Latin words meaning "to daub on" or "to stuff in."

7. Webster's Unabridged Dictionary defines "plaster" as "a composition of lime, water and sand with or without hair as a bond, for coating walls, ceilings and partitions of houses;" also as "calcined gypsum or plaster of Paris, especially when ground, as used for making ornaments, figures, moldings, etc."

8. For many years, plasters have been divided into two classes, interior and exterior plasters, depending upon the location or exposure of the surface to which the material is applied. Exterior plaster is better defined as "stucco" and should be so called. As a result, the above distinction is not necessary and by elimination, "plaster" means but one thing, namely: a coating for interior surface not exposed to weather.

9. Objection to this limitation in the definition of plaster will perhaps be made by those who use the term "exterior plaster" rather than stucco and the few using "stucco" to mean a special form of material for interior work.

10. It will be noted that the definition of "plaster" proposed in Part II, Section 4 (*a*), does not include uses of the material not given in either the root of the word or in its dictionary definition. The proposed definition merely limits the meaning of the word in order to make it a foundation on which can be built a collection of terms that will accurately describe the many various materials and mixtures used in plastering.

11. This restricted use of the word "plaster" will prevent the present confusion between plasters and the materials used in making plaster, and make clear at once the designed use of the material. Evidence of this confusion is found in the expression "Plaster of Paris," which to many has meant "plaster." The preceding definitions have shown that this material is not plaster, but rather is "calcined gypsum," which it should be called. Other confusing expressions are "stucco wall plaster," and "stucco plaster," which have been used in the past without regard to the location of the use of the material, and mean either interior or exterior wall covering material depending only upon the connection in which they are used or the nature of the product produced by the manufacturer marketing the materials. All these and similar misunderstandings are obviated by using the suggested definitions for "plaster" and "stucco."

(*C*) MORTAR.

12. The word "mortar" is derived from the Latin word "mortarium," meaning a vessel in which substances are pounded or rubbed, and later the pounded or rubbed substances. **Mortar.**

13. Webster's Unabridged Dictionary defines the word as "a building material made by mixing lime, cement or plaster of Paris with sand, water and sometimes other materials; used in masonry for joining stones, bricks, etc., also for plastering and in other ways." From this it appears that "mortar" means the same as that given in preceding paragraphs for stucco, plaster, and mortar.

14. The use of the word "mortar" as given in Part II, Section 5 (*a*), adds no new meaning, but restricts it to a particular use, rendering unnecessary such expressions as "stucco mortar,"

"plaster mortar," etc. It will also remove the confusion resulting from using the same expression to define materials used in making stuccoes, plasters and mortars.

(*D*) PLASTERS AND PLASTERING MATERIALS.

Plasters and Plastering Materials.

15. A careful distinction should be made between plaster and the materials used to make plaster. For instance, hydrated lime may or may not be mixed with sand or other aggregates and a binder to make plaster. In this case, if the plaster is used for scratch or brown coat work, no one individual material is plaster, but the completed mixture is plaster. It is obvious that the aggregate or fiber, even when water is added, does not constitute plaster; consequently the hydrated lime in this case is not justly considered plaster, as it is a part of the mixture in the same manner that the aggregate and binder are parts of the mixture. However, in finishing coat work, if calçined gypsum is not added to gage the mixture, the hydrated lime is plaster.

16. The statements in Section 15 are not contradictory when the definition for "plaster" in Part II, Section 4 (*a*), is carefully considered. Also, this distinction will cause no confusion in practice, as hydrated lime, or even calcined gypsum, is seldom used alone in finishing coat work, the two materials being mixed together to make finishing coat plaster.

17. An examination of literature descriptive of this class of plaster shows a confusing variety of different expressions, all of which are used in naming the same materials used for the same purpose. Some of these terms and the producers using them are as follows:

Cement Plaster is used by:

Plaster Manufacturers' Assoc.
U. S. Gypsum Co.
Michigan Gypsum Co.
Overland Gypsum Co.
American Gypsum Co.
Southern Gypsum Co.
Atlas Wall Plaster Co.
Texas Cement Co.
Arden Plaster Co.
Crown Gypsum Co.
Plymouth Gypsum Co.
Manitoba Gypsum Co.
American Cement Plaster Co.
Rock Plaster Mfg. Co.
J. B. King & Co.
The Alabastine Co.
Acme Cement Plaster Co.
Wotherspoon Plaster Mills, Inc.

18. From this list, which is only representative, it is evident that in the central and western parts of this country "cement plaster" is very generally used to mean "gypsum plaster." Without doubt, many people must think that "gypsum or calcined gypsum" means the same as "cement." This understanding must cause much confusions as there are a large number of people who consider cement to mean Portland, Rosendale, Keene's, etc., cement.

19. The suggested use of the terms "gypsum plaster" (Part VIII, Section 22 *(c) 1*) and "cement" (Part XIV, Glossary, Section 7) will prevent many misunderstandings.

20. *Hard Wall Plaster, Rock Wall Plaster, Patent Plaster, Calcined Plaster, Wall Plaster, Stucco Wall Plaster*, etc., are some of the expressions used to mean the material that has been defined as "gypsum plaster." These expressions have not been as generally used as "cement plaster," and of themselves may not have produced misunderstandings, since, with the exception of "stucco wall plaster," they have not been construed to mean other materials than "gypsum plaster." The expression "gypsum plaster" has an advantage over all these terms in that it denotes the particular cementitious material that is used in causing the plaster to harden.

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TENTATIVE RECOMMENDED PRACTICE FOR LAYING OF SEWER PIPE.[1]

Serial Designation: C 12 – 16 T.

Criticisms of this Tentative Recommended Practice are solicited and should be directed to Mr. Rudolph Hering, Chairman of Committee C-4 on Clay and Cement Sewer Pipes, 170 Broadway, New York, N. Y.

I. PREPARING TRENCHES AND FOUNDATIONS FOR PIPE LAYING.

The foundations in the trench should be formed to prevent any subsequent settlement and thereby possibly an excessive pressure and consequent rupture of the pipes. If the natural foundation is rock it is recommended that an equalizing sand bed be placed upon the rock and well compacted by watering or otherwise so as to obviate irregular settlement. If the natural foundation is good firm earth, the earth should be pared or molded to give a full support to the lower third of the pipe. Otherwise the bed should be made firm, either by sand well watered or rammed, or by a layer of cement mortar. The same means of securing a firm foundation should be adopted in case the excavation has been made slightly deeper than necessary.

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[1] These recommendations are limited to conditions which will affect the strength of pipes in their resistance to the external stresses, and are not intended to cover the art or practice in other respects. It is the intention of the committee that the acceptance of sewer pipes, to be furnished in compliance with the specifications for sewer pipes as finally presented to and adopted by the Society, shall be generally conditioned upon the substantial observance of the precautions formulated in the Recommended Practice for Laying of Sewer Pipe, as finally adopted by the Society.

If there is no good natural foundation, a firm and sufficiently broad bed should be artificially made either with sand, with gravel or broken stone, with concrete, reinforced concrete or other means to secure a solid and firm foundation.

If the soil is porous and ground water rises above the sewer pipe, a plank foundation with or without piles may be advisable,

When the sewer is to be laid in a concrete cradle, the concrete for the full width of the cradle should be continuously deposited to the height of the outside bottom of the pipe. Before the concrete has set the pipe should be evenly bedded therein and the remainder of the concrete immediately placed on each side of the pipe and carefully tamped in such a manner as to avoid disturbing its position. Or, the pipe may be supported and held in position by wedges or templates and the concrete mixed wet, and poured under and around it in such a manner as to complete the cradle in one operation.

When the sewer is to be laid in a gravel or broken-stone cradle, the material should consist of clean gravel or sound broken stone, all of which should preferably pass through a screen of 1-in. mesh and be retained on one of $\frac{1}{8}$-in. mesh. The gravel or broken stone should be deposited and consolidated for the full width of the trench to the height of the outside bottom of the pipe. The pipe should then be bedded therein and the remainder of the gravel or broken stone deposited and carefully consolidated in such a manner as to avoid disturbing the position of the pipe. The cradles should in all cases be so constructed that an excessive proportion of the load shall not be borne by the hubs.

If the trench is situated in ground water, it is recommended to lay the pipe in a concrete cradle up to the springing line to maintain firm joints.

When a sewer is to be laid without a cradle the earth forming the bed should be carefully freed from stones and organic material. The pipe should then be evenly bedded therein, the joints properly made and the backfilling placed and firmly tamped in such a manner as to avoid disturbing the position of the pipe.

When pipe is laid in soil which is not sufficiently firm to carry it, the earth or soil should be removed, and sufficiently broad foundations and retaining supports substituted.

When pipe is to be laid in new embankment the fill up to a point over the springing line of the pipe should be deposited in layers not exceeding 6 in. and thoroughly consolidated by rolling, ramming, teaming, watering or a combination of these, depending upon the nature of the filling material, whether it is clay, sand, gravel or a mixture of these.

If a pipe line is situated on one side of an embankment where the soil is liable to lateral movements, and is thus subjected to a one-sided load or pressure, care must be taken to secure a stable foundation, so that the pipe line will not be moved on its bed and broken. A retaining support should be placed at the side having the less pressure. It should be made with suitable material of proper height, width and weight, to transfer to the foundation the excessive lateral earth pressure, without danger to the stability of the pipe line.

Trenches should be kept free from water until the material in the pipe joints has hardened sufficiently so that the pipe line will be continuous and strong.

The stresses produced in pipe by the backfilling will differ according to the conditions of the soil. In self-sustaining soil it is possible to lay pipe at a considerable depth without producing excessive stresses. In soil which permits of lateral movement or which is water-carrying, special precautions are necessary to prevent undue pressure upon the pipes.

To protect pipe lines from unusual stresses all work should be done in open trenches. Tunneling should be prohibited except with the special consent of the engineer.

Pipe lines should be placed at such a depth below the surface of the street that dangerous pressure or impact cannot occur. If it is not possible to do this, special reinforcement is required.

Rock excavation should be made to a depth of at least 4 in. below the outside bottom of the pipe, or as shown on the plan.

Width of trenches in earth should be sufficient to provide a free working space of from 6 to 12 in., exclusive of spurs and hubs, according to the size of the pipe and the character of the ground.

The width of trenches in rock should be sufficient to provide a free working space of 12 in. on each side of the pipe exclusive of spurs and hubs.

In every case there should be sufficient space between the pipe and the sides of the trench to make it possible to thoroughly ram the backfilling around the pipe and to secure tight joints.

If soil conditions and ground water require the use of sheeting, sheet piling and bracing, the trenches should be made correspondingly wider. The sheeting should be closely driven and to such depths as the soil conditions may indicate to be necessary for the stability of the pipes.

Steel sheeting may be used with advantage where the flow of ground water into the trenches is excessive and the stability of the foundation soil and of the sewer is affected thereby.

Where a trench for a proposed sewer or extension of a sewer terminates in rock, it should be excavated for a distance of not less than 5 ft. beyond the end of the sewer and in the direction of the proposed extension. The pipes and all other structures should be carefully protected from the effects of blasts.

II. PIPE LAYING.

The laying of pipes in finished trenches should be commenced at the lowest point, so that the spigot end points in the direction of flow.

All pipes should be laid with ends abutting and true to line and grade. They should be fitted and matched so that when laid in the work they will form a sewer with a smooth and uniform invert.

It is necessary to use all possible care when shoving the pipes together, so that the joints will not be unnecessarily large.

Sockets should be carefully cleaned before pipes are lowered into trenches. The pipe should be so lowered as to avoid unnecessary handling in the trench. After the ends of the pipes have been sufficiently wetted, the hub end should receive upon its lower half a layer of mortar composed of one part of Portland cement to one or two parts of fine sand.

The pipe should be set firmly according to line and grade, and the joint carefully adjusted, filled with mortar and finished to a smooth bevel outside. The inside of the pipes should be then cleaned of dirt and mortar refuse. In small pipes the inside should be made smooth by a hand swab. Large pipes should be laid with block and tackle, and with bar and tongs.

Gasket and mortar joints should be made in the following manner: A closely twisted hemp or oakum gasket of suitable diameter, in no case less than $\frac{3}{4}$ in., and in one piece of sufficient length to pass around the pipe and lap at the top, should be solidly rammed into the annular space between the pipes with a suitable calking tool. Before being placed, the gasket should be saturated with neat cement grout. The remainder of the space should then be completely filled with plastic mortar mixed 1 : 1, and the joint wiped inside and finished to a smooth bevel outside.

Where butt or bevel joint pipes are used, the following method of joining is recommended: After a layer of mortar about 8 in. wide has been prepared at the joints, a wire netting is spread upon the same and covered with a layer of mortar about an inch thick. Upon this wire netting, which is embedded in the mortar, forming a bandage, the pipes are laid and adjusted according to line and grade. The bandage is then raised on both sides of the pipe, bound at the top, and covered with a layer of strong cement mortar at least 2 in. thick. The inside of the joint is finished in the same manner as specified for hub-and-spigot pipes.

The ends of pipes which enter masonry should be neatly cut to fit the face of the masonry.

No pipe or the cradle thereof should be laid or placed until the sub-grade of the trench has been tested and found correct.

In deep cuts, in high embankments or in poor soil, it is recommended to use concrete reinforcement.

The smaller sizes of cement or concrete pipes should preferably have flat bases. If of sufficiently large diameter, they may be reinforced.

When mortar or concrete are to be mixed or placed in freezing weather the following precautions are advised: No concrete should be laid when the temperature of the air is below 24° F. When the temperature is between 24 and 32° F., and rising, the mixing water should be heated to a temperature determined by the engineer, or he may advise that one per cent of salt, by weight, should be added for each degree of Fahrenheit of air temperature below 32° F. Under such conditions other materials for concrete and mortar should all be similarly heated.

III. BACKFILLING TRENCHES.

All trenches and excavations should be backfilled immediately after the pipes are laid therein, unless other protection of the pipe line is directed. The backfilling material should be selected and deposited with special reference to the future safety of the pipes. Clean earth, sand or rock dust should be used up to a level at least 2 ft. above the top of the pipe. This material should be carefully deposited in uniform layers about 6 in. in depth. Unless otherwise permitted, each layer should be carefully and solidly tamped or rammed with proper tools, so as not to injure or disturb the pipe line. The backfilling material for the remainder of the trenches should contain no stones over 10 in. in their largest dimensions. It should be spread in layers and thoroughly consolidated by tamping or otherwise as the engineer might direct. Stones which are used in backfilling should be so deposited through the mass that all interstices are filled with fine material.

Where the safety and stability of the pipe line and other structures render it necessary, sheeting should be left in place, particularly below the top of the pipe.

Where sheeting is withdrawn, all cavities remaining or adjoining the trench should be solidly filled. When the sheeting is left in place, all cavities behind such sheeting should be solidly filled.

For retaining backfilling temporarily, timber bulkheads may be used. They should be removed as the trenches are backfilled.

Puddling or water flooding for consolidating the backfilling is recommended only for sandy and gravelly materials. If this method is used, then the first flooding should be applied after the backfilling has been compacted by tamping up to the springing line of the pipe, and the second flooding during or after the subsequent filling of the trench. An excess of water should be avoided, in order to prevent disturbance of the earth under and around the pipe, and also to prevent an undue excess of pressure on the pipe.

Walking or working on the completed sewer, except as may be necessary in tamping or backfilling, should not be permitted until the trench has been backfilled to a height of at least 2 ft. over the top of the pipe.

Where a one-sided pressure exists, due to unbalanced loading, the filling of the trench should be carried on simultaneously on both sides and in such a manner that injurious side pressures do not occur.

In freezing weather backfilling should not contain any frozen lumps of earth below a level at least 2 ft. above the top of the pipe.

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TENTATIVE SPECIFICATIONS
FOR
SELECTED STRUCTURAL DOUGLAS FIR BRIDGE AND TRESTLE TIMBERS.

Serial Designation: D 23 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

I. DEFINITIONS.

Definitions.

1. The following definitions are used in connection with these specifications:

(*a*) *Annual Ring.*—Each annual ring is composed of two distinct types of wood structure, namely, the porous, light colored and light weight spring wood formed during the first part of the growing season and the hard, dense and darker colored summer wood formed during the latter part of the growing season.

(*b*) *Summer Wood.*—Summer wood is the hard, dense portion of the annual ring. It is darker in color than the more porous spring wood.

(*c*) *Sound and Tight Knot.*—A sound and tight knot is one which is solid across its face and which is as hard as the wood surrounding it; and is so fixed by growth or position that it will retain its place in the piece.

(*d*) *Encased Knot.*—An encased knot is one whose growth rings are not intergrown and homogeneous with the growth rings of the piece it is in. The encasement may be partial or complete; if intergrown partially or so fixed by growth or position that it will retain its place in the piece, it shall be considered a sound and tight knot.

(*e*) *Loose Knot.*—A loose knot is one not firmly held in place by growth or position.

(*f*) *Rotten Knot.*—A rotten knot is one not as hard as the wood it is in.

(*g*) *Measurement of Knots.*

In Beams, the diameter of a knot on the narrow or horizontal face shall be taken as its projection on a line perpendicular to the edge of the timber. On the wide or vertical face, the smallest dimension of a knot is to be taken as its diameter.

In Columns, the diameter of a knot on any face shall be taken as its projection on a line perpendicular to the edge of the timber.

(*h*) *Diagonal Grain.*—(Including cross and spiral grain). Diagonal grain is grain not parallel with all the edges of the piece.

(*i*) *Dense and Sound Douglas Fir.*—Under this heading two classes of timber are designated: (1) Dense Douglas fir and (2) sound Douglas fir. It is understood that these two terms are descriptive of the quality of the clear wood.

(*j*) *Dense Douglas Fir.*—Dense Douglas fir shall show on either one end or the other an average of at least 6 annual rings per inch or 18 rings in three inches and at least 33⅓ per cent summer wood, as measured over the third, fourth and fifth inches on a radial line from the pith, for girders not exceeding 20 in. in height, and for columns 16 in. square or less. For larger timbers the inspection shall be made over the central three inches on the longest radial line from the pith to the corner of the piece. Wide-ring material excluded by the above will be accepted provided the amount of summer wood as above measured shall be at least 50 per cent.

In cases where timbers do not contain the pith, and it is impossible to locate it with any degree of accuracy, the same inspection shall be made over three inches on an approximate radial line beginning at the edge nearest the pith.

The radial line chosen shall be representative. In case of disagreement between purchaser and seller as to what is a representative radial line, the average summer wood and number of rings shall be the average of the two radial lines chosen.

(*k*) *Sound Douglas Fir.*—Sound Douglas fir shall include pieces of Douglas fir without any ring or summer wood requirement.

II. GENERAL REQUIREMENTS.

General Requirements.

2. (*a*) The timber shall be only "Dense Douglas Fir" as defined in Section 1 (*j*).

(*b*) The timber shall be well manufactured, square edge and sawed standard size; solid and free from defects such as ring shakes and injurious diagonal grain, loose or rotten knots, knots in groups, decay, pitch pockets over 6 in. long or ⅜ in. wide, or other defects that will materially impair its strength.

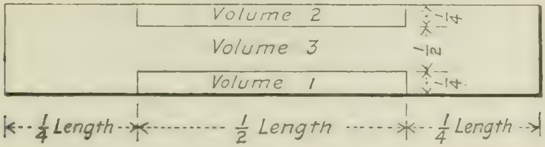

FIG. 1.

(*c*) Occasional variation in sawing, not to exceed ¼ in. scant at the time of manufacture, will be allowed.

(*d*) When timbers 4 by 4 in. and larger are ordered sized, they shall be ½ in. less than rough size, either S1S1E or S4S, unless otherwise specified.

III. STRINGERS, GIRDERS AND DEEP JOISTS.

Stringers, Girders and Deep Joists.

3. The timber shall show not less than 85 per cent of heart on each of the four sides, measured across the sides anywhere in the length of the piece. It shall not have in volumes 1 and 2 (Fig. 1) knots greater in diameter than one-fourth the width of the face in which they occur with a maximum of 1½ in. in diameter. It shall not have in volume 3 (Fig. 1) knots larger than one-third the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots within the center half

of the span shall not exceed in the aggregate the width of the face in which they occur. Diagonal grain in volumes 1 or 2 with a slope greater than 1 in 20 will not be permitted. When stringers are of two-span length they shall be considered as two separate pieces and the above restrictions applied to each half. The inspector shall place his stamp on the edge of the stringer to be placed "up" in service.

IV. CAPS AND SILLS.

Caps and Sills.

4. The timber shall show 85 per cent of heart on each of the four sides, measured across the sides anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

V. POSTS.

Posts.

5. The timber shall show not less than 85 per cent of heart on each of the four sides, measured across the face anywhere in the length of the piece, and shall be free from knots larger than one-fourth the width of the face in which they occur, with a maximum of 3 in. in diameter. Knots shall not be in groups.

VI. LONGITUDINAL STRUTS OR GIRTS.

Longitudinal Struts or Girts.

6. The timber shall show all heart on one face; the other face and two sides shall show not less than 85 per cent of heart, measured across the face or side anywhere in the length of the piece, and shall be free from knots over 2 in. in diameter.

VII. LONGITUDINAL X-BRACES, SASH BRACES AND SWAY BRACES.

Longitudinal X-Braces, Sash Braces and Sway Braces.

7. The timber shall show not less than 85 per cent of heart on two faces and shall be free from knots larger than one-third the width of the face in which they occur, with a maximum of 2 in. in diameter.

VIII. BRANDING.

Branding.

8. The inspector shall brand each timber which conforms to the above requirements "Selected Structural Douglas Fir."

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TENTATIVE SPECIFICATIONS
FOR
SOUTHERN YELLOW-PINE TIMBER TO BE CREOSOTED.

Serial Designation: D 24 – 15 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

General Requirements.

1. The specifications as to strength shall agree with the requirements that will be finally adopted by the Society under the Standard Definitions of Terms Relating to Structural Timber (Serial Designation: D 9);[1] that is, number of rings per inch or some substitute therefor. (Included in this section will also be a list of the allowable defects, etc.)

Sapwood.

2. All pieces shall show at least 30 per cent sapwood in cross-section. This is based on a minimum treatment of 12 lb. of creosote per cubic foot of timber.

Bridge Stringers.

3. In bridge stringers knots greater than 1½ in. in diameter shall be at least 4 in. from the edges of the stick. There shall be no knots more than 4 in. in greatest diameter in any part of the stick.

Caps and Sills.

4. Caps, sills, posts and sawed poles shall be free from knots more than 2½ in. in diameter.

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[1] See 1916 Volume of A.S.T.M. Standards.—Ed.

Bracing. 5. Longitudinal bracing, cross-arms and similar pieces having small cross-section shall have no knots more than 1 in. in diameter.

Track Ties. 6. Track ties shall show at least 20 per cent sapwood in cross-section. This is based on a minimum full-cell treatment of 8 lb. of creosote per cubic foot of timber.

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TENTATIVE SPECIFICATIONS
FOR
SOUTHERN YELLOW-PINE PILES AND POLES TO BE CREOSOTED.

Serial Designation: D 25 – 15 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

General Requirements. 1. The specifications as to strength shall agree with the requirements that will be finally adopted by the Society under the Standard Definitions of Terms Relating to Structural Timber (Serial Designation: D 9);[1] that is, number of rings per inch or some substitute therefor. (Included in this section will also be a list of the allowable defects, etc.)

Sapwood. 2. All piles or telegraph poles shall show 40 per cent sapwood in cross-section, or there shall be a ring of sapwood not less than 1 in. in thickness all around the heartwood.

Quality. 3. (*a*) Piles and poles shall be cut from sound live trees, of straight grain and regular taper; without crooks exceeding one-fourth the diameter of the stick at middle of crook when peeled. They shall be free from rot, red heart, holes or rotten knots, shakes and felling checks.

(*b*) All piles and poles shall have the bark and inner skin carefully removed when the tree is felled; all limbs and knots trimmed flush and butts cut square.

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[1] See 1916 Volume of A.S.T.M. Standards.—ED.

Minimum Diameter. 4. The minimum diameter of piles after peeling shall be as follows:

LENGTH.	BUTTS, IN.	TOPS, IN.
36 ft. and under	14	10
38 ft. and under 50 ft	14	9
50 ft. and over	15	9

No pile with butt diameter over 18 in., nor top diameter over 13½ in., will be accepted. The length of each pile is to be legibly marked on the butt with white or black paint.

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TENTATIVE SPECIFICATIONS
FOR
$2\frac{1}{2}$, 3 AND $3\frac{1}{2}$-IN. DOUBLE-JACKETED COTTON RUBBER-LINED FIRE HOSE FOR PUBLIC FIRE DEPARTMENT USE.

Serial Designation: D 26 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. E. A. Barrier, Chairman of Committee D-11 on Rubber Products, 31 Milk St., Boston, Mass.

I. COTTON FABRIC.

Quality of Cotton Fabric.

1. (*a*) The cotton fabric shall be even and firm in texture throughout and free from all injurious or unsightly defects, except such trifling ones as are incident to the best manufacturing practice. The filling threads (or weft) shall be thoroughly covered by the warp in woven fabric, while in knit fabric both warp and filling shall be covered by the knitted loop.

(*b*) The cotton cover shall consist of two plies, separate or interwoven.

II. RUBBER LINING.

Quality of Rubber Lining.

2. (*a*) The rubber lining shall be of uniform quality, free from defects, and as free from corrugations as may be possible with the best methods of manufacture.

(*b*) It shall contain, exclusive of cement and backing, not less than 40 per cent by weight, as found by analysis, of pure fine Para rubber or its equivalent, and shall not contain any kind of rubber substitutes, old vulcanized, or reclaimed rubber.

(*c*) It shall be cemented to the cotton fabric with cement which will meet requirements of Section 3 (*g*).

(*d*) It shall be lap-jointed, and the lap shall be as small and as neat as is consistent with the best results.

(*e*) The lining (without cement and backing) shall be made up of not less than three calendered sheets, and shall be not less than 0.058 in. in thickness, and, including cement and other backing, shall not exceed 0.090 in. in thickness.

Tests of Rubber Lining.

3. (*a*) The tensile strength shall be not less than 1600 lb. per sq. in.

(*b*) The length at time of breaking shall be not less than six times the initial length.

(*c*) Mark two lines on the test specimen 2 in. apart and at right angles to the direction of pull. Stretch to 10 in. and hold in that position for 10 minutes. Ten minutes after release, the distance between the two lines shall not exceed 2.4 in.

(*d*) The compound used shall not contain more than 7.5 per cent of sulfur, exclusive of that which may be contained in the mineral matter, as barytes, and the free sulfur shall not exceed 3 per cent; both figures shall be based upon the amount of gum as found by chemical analysis.

(*e*) The organic-acetone extract shall not exceed 5 per cent of the gum as found by chemical analysis.

(*f*) The saponifiable matter extracted by alcoholic potash after the acetone extraction has been made shall not exceed 2 per cent of the gum as found by chemical analysis.

(*g*) The adhesion, or "friction," between the cement backing and the cotton fabric, shall be such that when a 9-lb. weight is suspended from the free end of a 1-in. strip of the lining cut circumferentially from the hose, the lining shall not separate from the backing or fabric at a rate greater than 1 in. per minute.

III. HOSE.

Diameter of Hose.

4. The internal diameter of the hose shall be not less than the size called for in the schedule, namely 2½, 3 or 3½ in.

Weight and Flexibility of Hose.

5. (*a*) The weight of the finished hose per 50-ft. length without couplings shall be not more than the following amounts:

Size of Hose, in.	Max. Weight per 50-ft. Length, lb.
2½	70
3	90
3½	110

(*b*) The hose shall be flexible and easily coiled.

Strength of Hose.

6. (*a*) The hose shall meet the following requirements for minimum bursting pressure. Tests on 50-ft. lengths need not be made unless specified by the purchaser.

When Lying Straight.

Length of sample, ft	3	50
Bursting pressure, min., lb. per sq. in	600	500

When Bent in a Curve the Radius of Which is 2½ ft.

Length of sample, ft	3	50
Bursting pressure, min., lb. per sq. in	600	500

With Ends Tied Together and Couplings Touching, and with a Sharp Kink in the Middle.

Bursting pressure, min., lb. per sq. in	...	350

(*b*) Every length of hose shall be tested by the manufacturer after coupling but before delivery, with 400 lb. pressure. It shall be carefully dried before shipment.

Elongation of Hose.

7. The elongation between 10 and 100 lb. shall not exceed 3 per cent and between 10 and 400 lb. 8 per cent of the original length, as measured at 10 lb. pressure.

Distortion of Hose.

8. The hose shall not twist more than 12 deg. per foot at 400 lb. pressure. The twist shall be in such direction as to tighten rather than loosen the couplings.

Marking of Hose.

9. Each 50-ft. length of hose shall be stenciled twice in black letters 1 in. high, beginning not more than 4 ft. from the couplings, as follows: "A. S. T. M. Specifications," also with the name of the manufacturer, the month and year of manufacture, and the words "tested to 400 lb."

Couplings.

10. (*a*) Couplings shall be made, finished and fitted in a workmanlike manner throughout. The diameter through couplings shall be according to the size of the hose, namely, 2½, 3, or 3½ in.

(*b*) They shall be of the expansion-ring pattern, of ample strength, and of the best form to resist the strain of expanding the binding ring in the coupling. They shall have a tail part sufficiently long to extend ⅛ in. beyond the end of the expansion ring. They shall be fitted with expansion rings having the following lengths and gaskets of the following thickness:

SIZE OF HOSE, IN.	LENGTH OF EXPANSION RINGS, IN.	THICKNESS OF GASKETS, IN.
2½	1½	$\frac{3}{16}$
3	1¾	¼
3½	2½	¼

(*c*) They shall be made of an alloy of copper, tin and zinc (and lead if desired) of the following proportions:

Copper	not under 82 per cent.
Tin	" " 5 "
Zinc	" over 7 "
Lead	" " 3 "

Couplings, including both male and female and expansion rings, shall weigh not less than the following amounts:

SIZE OF HOSE, IN.	MINIMUM WEIGHT PER SET OF COUPLINGS, LB.
2½	5¾
3	8
3½	12½

Both male and female shall be stamped with the name of the manufacturer of the couplings and the month and year of manufacture in letters and figures not less than ⅛ in. high.

(*d*) They shall be provided with rubber gaskets of the same quality as the rubber lining, and accurately fitted.

(*e*) They shall have on the couplings, inside each expansion ring, a rubber washer at least $\frac{3}{16}$ in. in thickness and with inside diameter not less than that of the coupling. Hose coupling threads shall be interchangeable with those now in use in the city or town, but wherever practicable an effort should be made to introduce the "National Standard" thread adopted in 1906 by the National Fire Protection Association.

The essential features of the "National Standard" are a

60-deg. V-thread, and the following more important features for the different sizes:

SIZE OF COUPLINGS, IN.	NUMBER OF THREADS PER INCH.	OUTSIDE DIAMETER OF MALE THREADS, IN.
$2\frac{1}{2}$	$7\frac{1}{2}$	$3\frac{1}{16}$
3	6	$3\frac{5}{8}$
$3\frac{1}{2}$	6	$4\frac{1}{4}$

NOTES.

In many cases where the number of threads and the outside diameters of the male ends do not differ greatly from the Standard, it is possible to render both male and female couplings adaptable for interchange with the Standard by the use of an adjustable tap for the female end or an adjustable die for the male end of the coupling. This tap or die should have the same number of threads per inch as the coupling or nipple to be treated.

In cases where the above change in the existing equipment cannot be made, the hydrant nipples can be equipped with adapters provided with spanner lugs and having a Standard male thread on the out-board end.

Two and one-half inches is specified above as the diameter for the smaller hose since this size is standard throughout the country for Public Fire Department use. It is recommended however that an effort be made to introduce the use of $2\frac{5}{8}$-in. hose, which has practically replaced the $2\frac{1}{2}$-in. hose for private department use for many years. The $2\frac{5}{8}$-in. hose has about 20 per cent less friction loss than the $2\frac{1}{2}$-in. hose and can be used without difficulty on the present equipment of couplings and playpipes. When $2\frac{5}{8}$-in. hose is used the specifications for $2\frac{1}{2}$-in. hose should apply with the exception of weight, in which case the maximum weight should be 75 lb. per 50-ft. length.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE SPECIFICATIONS

FOR

INSULATED WIRE AND CABLE: 30 PER CENT HEVEA RUBBER.

Serial Designation: D 27 – 16 T.

Criticisms of these Tentative Specifications are solicited and should be directed to Mr. E. A. Barrier, Chairman of Committee D-11 on Rubber Products, 31 Milk Street, Boston, Mass.

Scope. 1. These specifications cover conductors and rubber insulation only. The design and factor of safety depend upon the service conditions and shall be at the option of the purchaser.

(*A*) *Conductor.*

I. MANUFACTURE.

Material. 2. The conductor shall be made of soft annealed copper, properly tinned, and have the properties and characteristics herein required.

Strand. 3. Each individual wire of a stranded conductor shall be considered separately and shall be designated as a strand.

Shape. 4. Each solid conductor and each strand shall be round and reasonably free from imperfections.

Stranding. 5. The stranding shall be concentric, unless otherwise specified, and shall conform to Table I.

Density. 6. For the purpose of calculating weights, cross-sections, etc., in conductivity determinations, the density of the copper shall be taken as 8.89. See Appendix I.

TABLE I.—STRANDING.

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Sizes.	Minimum Number of Strands in Conductor.
2 000 000 to 1 600 000 C. M.	127
1 500 000 " 1 100 000 "	91
1 000 000 " 550 000 "	61
500 000 " 250 000 "	37
No. 0000 " No. 1 A. W. G. or B. & S.	19
No. 2 " No. 8 " "	7
Smaller sizes	1

II. PHYSICAL PROPERTIES AND TESTS.

Tensile Properties. 7. Each solid conductor or strand shall be so drawn and annealed that after tinning it shall conform to the properties given in Table II.

TABLE II.—TENSILE PROPERTIES.

(AMERICAN SOCIETY FOR TESTING MATERIALS.)

Diameter, in.	Maximum Tensile Strength, lb. per sq. in.	Minimum Elongation in 10 in., per cent.
0.460 to 0.290	36 000	35
0.289 " 0.103	37 000	30
0.102 " 0.021	38 500	25
0.020 " 0.003	40 000	20

Tension Tests. 8. (*a*) *Method of Test.*—Tensile tests shall be made on fair samples and the elongation shall be determined as the permanent increase in length, due to the breaking of the wire in tension, measured between bench marks originally 10 in. apart. The specimen shall break between the bench marks and not closer than 1 in. to either mark.

(*b*) *Number of Tests.*—Samples shall be taken in accordance with Section 16.

(*c*) *Retests and Rejections.*—If upon testing a sample from a coil, reel or spool of wire, the results are found to be above the stated value for tensile strength or below the stated value for elongation, tests upon two additional samples will be made and the average of the three tests shall determine acceptance or rejection.

Conductivity. 9. The conductivity of the copper shall be not less than 98 per cent of the annealed copper standard. See Appendix I.

Tinning Tests. 10. (*a*) *Test.*—Each sample before stranding or insulating shall be given the following tests at the factory: The sample shall be thoroughly cleaned by immersing in redistilled petroleum ether, followed by immersion in 95 per cent alcohol. The sample shall then be immersed in hydrochloric acid (sp. gr. 1.088) at a temperature of from 60 to 70° F. (15°.55–21°.10 C.) for one minute, washed in distilled water (the surplus water shaken off) and immersed in a solution of sodium sulfide for 30 seconds and again washed in water (the surplus water shaken off). The above operation shall be repeated four times for samples 0.02 in. in diameter or over, and three times for samples less than 0.02 in. in diameter. After the completion of the required number of cycles the samples shall not show any sign of blackening in the air which is perceptible to the eye.

(*b*) *Strength of Solution.*—The solution of sodium sulfide shall have sufficient strength to thoroughly blacken in 5 seconds a piece of untinned copper wire that has previously been cleaned in 95 per cent alcohol. The solution shall be prepared by thoroughly saturating (by boiling) a solution of sodium monosulfide with sulfur and shall have a specific gravity of 1.142 at 60° F. (15°.55 C.).

(*c*) *Number of Tests.*—Samples shall be taken in accordance with Section 16.

(*d*) *Retests and Rejections.*—If the specimen tested in accordance with Section 10 (*a*) shows any signs of blackening, two more specimens shall be tested. If one of these two additional specimens shows any signs of blackening, that coil or reel shall be rejected. If both specimens are free from any signs of blackening, the coil or reel shall be accepted. If more than

10 per cent of the samples in the entire order fail, all of the wire shall be rejected. If 10 per cent or less of the samples in the entire lot fail, each coil, reel or length may be tested and accepted or rejected upon the results of the individual tests.

III. PERMISSIBLE VARIATIONS IN DIMENSIONS.

Diameter and Area.

11. (*a*) *Permissible Variation.*—When the diameter of solid conductors and strands is specified, the permissible variation from the specified value shall not exceed 1 per cent under or 2 per cent over for wire 0.02 in. in diameter and larger, and 0.1 mil under for wire less than 0.02 in. in diameter.

When the area of cross-section is specified, the permissible variation shall not exceed 2 per cent under the specified value.

(*b*) *Method of Gaging Diameter.*—When wire is submitted in coils, each coil shall be gaged in three places, one near each end and one approximately at the middle. When wire is submitted on spools or reels, approximately 12 ft. of the wire shall be reeled off and the wire then gaged in six places between the second foot and the twelfth foot from the end.

(*c*) *Calculation of Area.*—The area of cross-section of wire shall be calculated from the average of the measurements of the diameter made in accordance with Section (*b*). The area of cross-section of cable shall be considered to be the sum of the cross-sectional areas of its component wires, when laid out straight and measured perpendicular to their axes.

(*d*) *Rejection.*—A coil or reel shall be rejected if the average diameter obtained from the measurements made in accordance with paragraph (*b*), or the area as calculated in accordance with paragraph (*c*), is not within the limits specified in paragraph (*a*).

A coil or reel shall be rejected if any individual measurement of diameter or of area of cross-section is not within twice the limits specified in paragraph (*a*).

(*B*) *Insulation.*

IV. CHEMICAL PROPERTIES AND TESTS.

Composition of Compound.

12. (*a*) *Composition.*—The insulation shall contain exclusively Hevea rubber which has not been previously used, waxy hydrocarbons consisting of ceresin or refined paraffin, sufficient

sulfur to properly vulcanize, and fillers which are entirely inorganic mineral matter containing no red lead, carbon or bitumen.

(*b*) *Requirements.*—The vulcanized compound shall conform on analysis to the following requirements expressed as percentages, by weight, of the whole sample:

	MAXIMUM.	MINIMUM.
Rubber	33	30
Waxy hydrocarbons	4	..
Free sulfur	0.7	..

Results shall be taken between the limits given in proportion to the percentage by weight of the rubber found.

The limits allowed for 30-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.35	0.55
Unsaponifiable resins	0.45	....
Chloroform extract	0.90	....
Alcoholic potash extract	0.55	....
Total sulfur (see note)	2.10	....
Specific gravity	....	1.75

The limits allowed for 33-per-cent rubber compound shall be as follows:

	MAXIMUM.	MINIMUM.
Saponifiable acetone extract	1.50	0.60
Unsaponifiable resins	0.50	....
Chloroform extract	1.00	....
Alcoholic potash extract	0.60	....
Total sulfur (see note)	2.30	....
Specific gravity	....	1.67

The acetone solution shall not fluoresce.

The acetone extract (60 cc.) shall not be darker than a light straw color.

Hydrocarbons shall be solid, waxy and not darker than a light brown.

Chloroform extract (60 cc.) shall not be darker than a straw color.

Contamination of the compound, such as by the use of impregnated tapes, will not excuse the manufacturer from conforming to this specification.

NOTE.—The limit on total sulfur may be omitted at the option of the purchaser.

The compound shall be analyzed by the procedure recommended by the Joint Rubber Insulation Committee. See Appendix II.

(*c*) *Samples.*—Samples for chemical analysis shall be taken before the application of the braid and after the material has passed all physical and electrical tests. The purchaser may take samples in accordance with Section 16. The purchaser shall assure himself that all samples are free from contamination and change due to torch heating. Wherever practicable, samples shall be taken at a distance of at least 3 ft. from the end of the wire.

(*d*) *Retests and Rejections.*—The purchaser may make a chemical analysis on any one of the samples selected as above to determine if the compound meets the requirements of Section 12 (*b*). Failure of any one sample selected shall be sufficient cause to reject the wire which the sample represents, except in the case of failure to meet the requirements of either or both free sulfur and chloroform extract in accordance with Section 12 (*b*). In case of such failure the coil from which the sample was taken shall be rejected and two additional samples taken from the remainder of the order. The remainder of the order shall be accepted if both samples so selected shall meet the requirements for free sulfur or chloroform extract in accordance with Section 12 (*b*). The entire order shall be rejected if either sample fails to meet the requirements.

V. PHYSICAL PROPERTIES AND TESTS.

Physical Properties.

13. The test specimen shall have the following physical properties.

Tensile strength, minimum, lb. per sq. in.	1000
Set, maximum in 2 in., in.	$\frac{3}{8}$
Elongation, minimum before rupture, in.	2 to 9

Physical Tests.

14. (*a*) *Tension Test.*—A test specimen having a length of not less than 2 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a test machine (maximum distance

between jaws holding the test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the specimen breaks. The test specimen shall break between the bench marks and the tensile strength shall be calculated upon the area of the original sample.

(*b*) *Set Test.*—A second test specimen having a length of not less than 6 in., marked with bench marks 2 in. apart, shall be placed in the jaws of a test machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at a rate of 20 in. per minute until the bench marks are 6 in. apart. After the termination of this stretch, the test specimen shall be released within 5 seconds and the set determined 1 minute after the beginning of release.

(*c*) *Elongation Test.*—After the determination of the set in accordance with paragraph (*b*), the *same* specimen shall be placed in the jaws of a test machine (maximum distance between jaws holding test specimen, 4 in.) and stretched at the rate of 20 in. per minute (jaw speed) until the specimen breaks. The test specimen shall break between the bench marks.

(*d*) *Accuracy of Machine.*—The test machine shall be accurate within 1 per cent of the breaking load.

(*e*) *Jaws.*—The jaws of the machine shall be of an approved type.

(*f*) *Temperature.*—All physical tests shall be made at a room temperature of from 65 to 85° F. (18°.33 to 29°.44 C.) inclusive, and the test specimen shall have been kept at the room temperature not less than 30 minutes prior to the tests.

Test Specimen.

15. (*a*) *Test Specimen.*—The test specimen may be the entire section of the insulation in the case of small wires, or in the case of a large wire, a segment of a section, cut with a sharp knife held tangentially to the conductor. The test specimen shall be as free as possible from surface incisions and imperfections.

(*b*) *Buffing.*—In event of any irregularities on the surface of the test specimen, it shall be made smooth and of uniform thickness within 5 per cent of the original thickness by buffing, except when large strands are used, in which case the rubber sample shall be buffed sufficiently to remove all corrugations.

(*c*) *Limits.*—There shall be no limit to the cross-section of the test specimen, except as restricted by the capacity of the test machine.

(*d*) *Calculation of Area.*—Calculation of the area of test specimen shall be made as follows:

(1) When the total cross-section of the insulation is used, the area shall be calculated as the area of the circle whose diameter is the minimum average outside diameter of the insulation minus the area of the conductor. The area of a stranded conductor shall be figured from its maximum diameter.

(2) When a slice cut from the wire by a knife held tangent to the wire is used, and the slice so cut has the cross-section of a segment of a circle, the area shall be calculated as that of the segment of a circle whose diameter is that of the insulation. The height of the segment is the wall of insulation on the side from which the slice is taken. (The values are most easily obtained from a table giving the areas of segments of a unit circle for the ratio of the height of the segment to the diameter of the circle.)

(3) When the cross-section of the slice is not a segment of a circle, the area shall be calculated from a direct measurement of the volume or from the specific gravity and the weight of a known length of a uniform cross-section.

(4) When a portion of a sector of a circle has to be taken (as in the case of large conductors with thin walls) the area shall be calculated as the thickness times the width. (This applies either to a straight test piece or one stamped out with a die, and assumes that corrugations have been removed by buffing.)

(5) When a portion of a sector of a circle has to be taken on large conductors with thick walls the area shall be calculated as the proportional part of the area of the total cross-section.

Number of Physical Test Specimens.

16. (*a*) *Less than 500 Feet.*—When an order calls for less than 500 ft., physical tests shall be waived.

(*b*) *Over 500 Feet.*—When an order calls for 500 ft. or more and is made into one or more coils, reels or lengths, samples shall be taken from 10 per cent of the coils, reels or lengths, but in all cases there shall be one sample taken.

Retests and Rejections, Physical Tests.

17. (*a*) *Retests.*—If a specimen fails to pass in either of the three tests prescribed in Section 14, two more specimens shall be taken from the same sample and the average of the results shall determine whether or not the sample complies with the requirements.

(*b*) *Rejections.*—When ten or more samples are selected in any inspection lot, all coils, reels or lengths shall be rejected if more than 10 per cent of the samples fail. If 10 per cent or less fail, each coil, reel or length may be tested and shall be accepted or rejected upon the result of individual test. Where the number of samples selected in any inspection lot is less than ten, all coils, reels or lengths shall be rejected if more than 20 per cent of the samples fail. If 20 per cent or less fail, each coil, reel or length may be tested and shall be accepted or rejected upon the result of individual test.

TABLE III.—VALUES OF TEST POTENTIALS, IN KILOVOLTS.

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths in.							
	2	3	4	5	6	7	8	10
18 A. W. G. or B. & S.	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
16 " "	1.0	2.5	4.5	5.5	6.5	7.5	8.5	10.5
14 " "	...	2.5	5.0	6.0	7.0	8.0	9.0	11.0
12 " "	...	2.5	5.0	6.0	7.5	8.5	9.5	11.5
10 " "	...	3.0	5.0	6.5	8.0	8.5	10.0	12.0
8 " "	...	3.0	5.0	7.0	8.0	9.5	11.0	13.0
6 " "	...	...	5.0	6.5	8.5	10.0	11.5	14.0
4 " "	...	...	4.5	6.5	8.5	10.0	11.5	14.5
2 " "	...	...	4.0	6.0	8.0	10.0	12.0	15.0
0 " "	...	...	...	5.5	8.0	10.0	12.0	15.5
00 " "	...	...	...	5.0	7.5	9.5	11.5	15.5
000 " "	...	...	...	5.0	7.5	9.5	11.5	15.5
0000 " "	...	...	...	4.5	7.0	9.0	11.5	15.5
250 000 C. M.	...	...	...	4.0	6.5	9.0	11.0	15.5
500 000 "	...	...	...	2.5	5.0	7.5	10.0	14.5
750 000 "	...	...	...	...	...	6.5	9.0	14.0
1 000 000 "	...	...	...	...	...	5.5	8.0	13.0
1 250 000 "	...	...	...	...	...	...	7.5	12.5
1 500 000 "	...	...	...	...	...	...	7.0	12.0
1 750 000 "	...	...	...	...	...	...	6.5	11.5
2 000 000 "	...	...	...	...	...	...	5.0	10.5

VI. ELECTRICAL PROPERTIES AND TESTS.

Electrical Properties.

18. (*a*) *Place.*—All electrical tests shall be made at the factory.

(*b*) *Requirements.*—Every coil, reel or length of wire, after vulcanization and before the application of paraffin or

TABLE IV.—INSULATION RESISTANCE, IN MEGOHM-MILES AT 60° F.[1]

(ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.)

Size of Conductors.	Thickness of Insulation, 64ths in.																
	2	3	4	5	6	7	8	10	12	14	16	18	20	22	24	26	28
18 A. W. G. or B. & S.	1600	2050	2450	2800	3000	3200	3400	3750	4050	4300	4500	4700	4900	5000	5150	5300	5400
16 " "	1400	1800	2150	2400	2650	2850	3050	3400	3650	3950	4150	4350	4500	4650	4800	4900	5050
14 " "		1530	1850	2150	2350	2550	2650	3050	3350	3550	3800	3950	4100	4300	4400	4550	4650
12 " "		1350	1600	1850	2050	2250	2400	2750	3000	3250	3400	3600	3750	3900	4050	4150	4300
10 " "		1150	1350	1600	1800	2000	2150	2400	2650	2900	3100	3250	3400	3550	3700	3800	3900
8 " "		850	1050	1250	1450	1650	1750	2050	2200	2400	2600	2750	2900	3050	3150	3250	3350
6 " "			850	1050	1200	1350	1450	1750	1950	2100	2300	2450	2550	2700	2800	2900	3000
4 " "			750	850	1000	1150	1250	1450	1650	1850	2000	2150	2250	2400	2500	2600	2700
2 " "			650	750	850	950	1050	1250	1450	1600	1700	1850	1950	2100	2200	2300	2400
1 " "			600	650	750	850	1000	1150	1350	1450	1600	1750	1850	1950	2050	2150	2250
0 " "				600	700	800	950	1050	1200	1350	1500	1600	1700	1800	1900	2000	....
00 " "				550	650	750	850	950	1050	1250	1350	1500	1600	1700	1800	....	....
000 " "				500	600	650	750	850	1000	1150	1250	1350	1450	1550	....	....	....
0000 " "				450	550	600	650	800	950	1050	1150	1250	1350	1450	....	....	....
250 000 C. M.				400	475	575	625	725	875	1000	1100	1200	1275	....	....	....	....
350 000 "				350	425	475	525	675	775	850	950	1050	1125	....	....	....	....
500 000 "				300	375	400	475	575	675	750	850	900	....	....	....	....	....
750 000 "						325	400	475	525	625	700	775	....	....	....	....	....
1 000 000 "						300	325	400	475	550	625	....	....	....	....	....	....
1 250 000 "							325	375	425	500	575	....	....	....	....	....	....
1 500 000 "							300	325	400	475		....	....	....	....	....	....
1 750 000 "							275	300	375	450		....	....	....	....	....	....
2 000 000 "							200	275	325	425		....	....	....	....	....	....

NOTE.—For intermediate sizes, use values of next larger size.

[1] This table is based on the constant 4000 in the following formula:

$R = K \log \frac{D}{d}$, where R = resistance in megohms, K = Constant, D = diameter over insulation, d = diameter over conductor.

any covering other than tape or braid used in vulcanization, shall successfully withstand a high voltage test as specified in Table III, and shall have an insulation resistance not less than that specified in Table IV. These tests shall be made after not less than 18 hours immersion in water, and while still immersed.

High Voltage Test.

19. The test voltage shall be applied for 5 minutes. The test shall be made in accordance with the Standardization Rules of the American Institute of Electrical Engineers. See Appendix I.

TABLE V.

(TESTS SHALL BE MADE AT TEMPERATURES WITHIN THE SCOPE OF THIS TABLE.)

Temperature.		Coefficient.	Temperature.		Coefficient.
Deg. Fahr.	Deg. Cent.		Deg. Fahr.	Deg. Cent.	
46	7.8	0.694	61	16.1	1.026
47	8.3	0.709	62	16.7	1.053
48	8.9	0.729	63	17.2	1.081
49	9.4	0.746	64	17.8	1.109
50	10.0	0.769	65	18.3	1.138
51	10.6	0.787	66	18.9	1.169
52	11.1	0.806	67	19.4	1.200
53	11.7	0.833	68	20.0	1.231
54	12.2	0.854	69	20.6	1.264
55	12.8	0.877	70	21.1	1.297
56	13.3	0.900	71	21.7	1.331
57	13.9	0.917	72	22.2	1.366
58	14.4	0.943	73	22.8	1.402
59	15.0	0 970	74	23.3	1.438
60	15.6	1.000	75	23.9	1.477

Insulation Resistance.

20. (*a*) *Method.*—This test shall be made in accordance with the Standardization Rules of the American Institute of Electrical Engineers. See Appendix I.

(*b*) *Temperature Coefficient.*—The insulation resistance (megohms) shall be reduced to that at 60° F. (15°.55 C.) by multiplying by the coefficient in Table V corresponding to the temperature at which test is made.

Rejections. Electrical Test.

21. Every coil, reel or length shall be rejected if it fails to comply with the electrical requirements herein specified.

(*C*) *Inspection.*

Inspection.

22. (*a*) The manufacturer shall notify the purchaser sufficiently in advance of the completion of the wire or cable to permit of arrangement for the inspection.

(*b*) The inspector representing the purchaser shall have free entry at all times, while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the wire ordered, except compounding room. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the wire is being furnished in accordance with these specifications. Tests and inspection shall be made prior to shipment, at the place of manufacture.

(*c*) The purchaser may make the tests to govern the acceptance or rejection of the wire in his own laboratory or elsewhere. Such tests, however, shall be made at the expense of the purchaser.

Rehearing.

23. Samples of rejected material shall be preserved for two weeks from date of test report. In case of dissatisfaction with the results of test, the manufacturer may make claim for a rehearing within that time. Sealed duplicate samples may be retained by the manufacturer at his option.

APPENDIX I.

EXTRACTS FROM STANDARDIZATION RULES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

(Edition July 1, 1915.)

Conductivity of Copper.

1. The following shall be taken as normal values for standard annealed copper:

(*a*) At a temperature of 20° C. the resistance of a wire of standard annealed copper 1 m. in length and of a uniform section of 1 sq. mm. is 1/58 ohm = 0.017241 ohm.

(*b*) At a temperature of 20° C. the density of standard annealed copper is 8.89 g. per cubic centimeter.

(*c*) At a temperature of 20° C. the "constant mass" temperature coefficient of resistance of standard annealed copper, measured between two potential points rigidly fixed to the wire, is 0.00393 = 1/254.45 . . . per degree Centigrade.

(*d*) As a consequence, it follows from (*a*) and (*b*) that at a temperature of 20° C. the resistance of a wire of standard annealed copper of uniform section, 1 m. in length and weighing 1 g. is $(1/58) \times 8.89 = 0.15328$ ohm.

High Voltage Test.

(*a*) *Frequency.*

2. The frequency of the test voltage shall not exceed 100 cycles per second, and should approximate as closely as possible to a sine wave. The source of energy should be of ample capacity.

(*b*) *Rate of Increase of Voltage.*

3. The initially-applied voltage shall not be greater than the working voltage and the rate of increase shall not be over 100 per cent in 10 seconds.

INSULATION RESISTANCE TEST.

4. The apparent insulation resistance should be measured after the dielectric-strength test, measuring the leakage current after a one-minute electrification, with a continuous e.m.f. of from 100 to 500 volts, the conductor being maintained positive to the water.

APPENDIX II.

JOINT RUBBER INSULATION COMMITTEE PROCEDURE FOR THE ANALYSIS OF RUBBER COMPOUND.

Object of the Analysis.

1. The object of this procedure of analysis is to determine whether rubber compounds comply chemically with the accompanying specification which is intended to secure compounds containing 30 per cent of the best Hevea rubber, and mineral fillers.

Outline of Procedure.

2. The general procedure is shown in Fig. 1.

General.

3. Make the analysis upon the insulation after vulcanization and, whenever possible, before the saturation of the braid. Wipe the insulation thoroughly with a damp cloth to remove any adhering material, but do not remove waxy hydrocarbons from the surface.

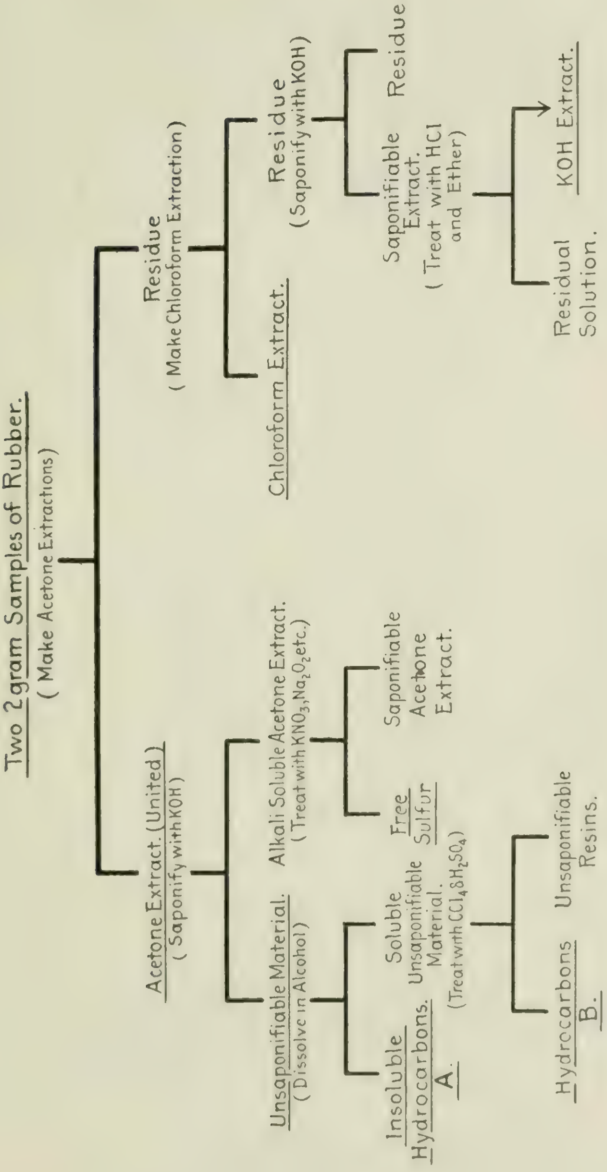
4. If, however, a saturated braided sample must be used, remove the braid and sandpaper the insulation to a depth oi at least 5/1000 in. and wipe with a damp cloth. In such cases report the condition of the sample.

5. Perform all determinations in duplicate and take the average value arbitrarily as the true value. Duplicate determinations must check within the limits specified.

6. Make blanks on all determinations and deduct the results accordingly.

Sample.

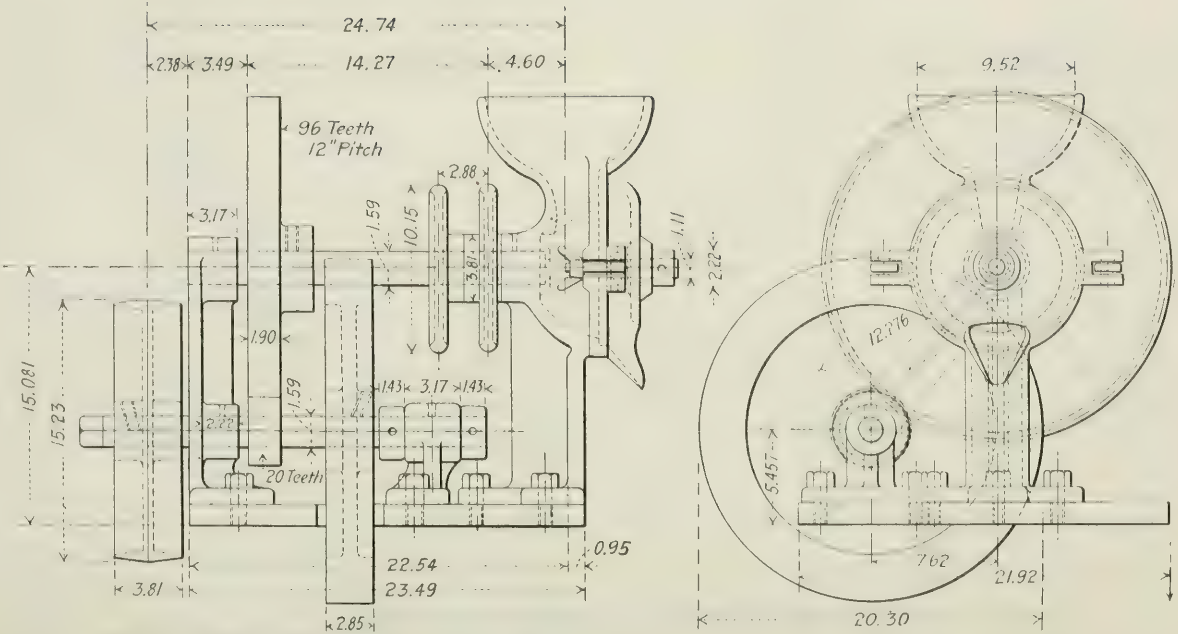
7. Remove the insulation entirely from sufficient wire to give a sample weighing about 25 g. Cut this into small strips and grind slowly in either a No. 0 Enterprise coffee mill or a


Two 2 gram Samples of Rubber.
(Make Acetone Extractions)
Acetone Extract. (United)
(Saponify with KOH)
Residue
(Make Chloroform Extraction)
Unsaponifiable Material.
(Dissolve in Alcohol)
Alkali Soluble Acetone Extract.
(Treat with KNO3, Na2O2 etc.)
Chloroform Extract.
Residue
(Saponify with KOH)
Insoluble Hydrocarbons. A.
Soluble Unsaponifiable Material.
(Treat with CCl4 8H2SO4)
Free Sulfur
Saponifiable Acetone Extract.
Saponifiable Extract.
(Treat with HCl and Ether)
Residue
Hydrocarbons B.
Unsaponifiable Resins.
Residual Solution.
KOH Extract.

Total Waxy Hydrocarbons = A + B.

Weigh Substances with Names Underlined;
Other Substances by Difference.

FIG. 1.—Outline of Method For Rubber Analysis.
(Exclusive of Fillers and Total Sulfur Determinations.)

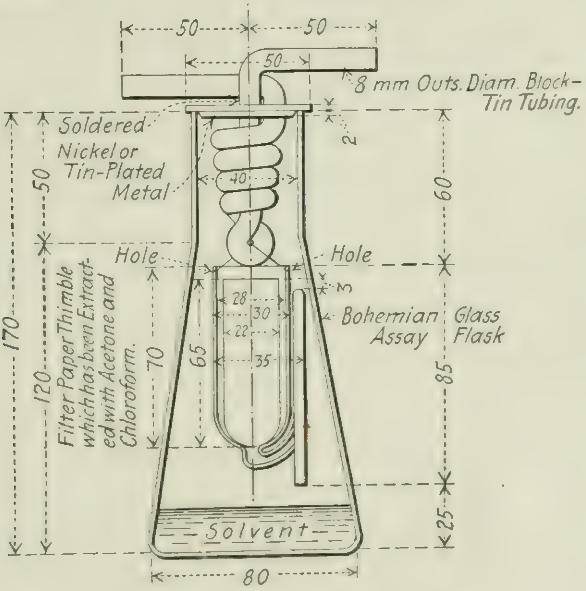


Grinding Plates of the No. 0
Enterprise Coffee Mill to be Used.

(All Dimensions in Centimeters.)

FIG. 2.—Rubber Grinder.

mill such as shown by Fig. 2. Adjust the grinder so that not more than 20 per cent will pass through a 40-mesh sieve. Sift all the material through a 20-mesh sieve, regrinding what is retained on the sieve until the entire sample has passed through. The wires of the sieves shall be evenly spaced in both directions and shall be of 0.016 and 0.010 in. diameter in the 20- and 40-mesh sieves respectively. Remove with a strong magnet any metal that may have come from the grinder and thoroughly mix the sample.


50
50
50
8 mm Outs. Diam. Block-Tin Tubing.
Soldered Nickel or Tin-Plated Metal
2
40
60
50
170
120
Hole
Hole
3
28
30
22
35
70
65
Bohemian Assay Glass Flask
85
25
Filter Paper Thimble which has been Extracted with Acetone and Chloroform.
Solvent
80

(All dimensions in millimeters.)

FIG. 3.—Extraction Apparatus.

EXTRACTION APPARATUS.

8. The extraction apparatus shall conform to Fig. 3. It shall be heated so that the period of filling an empty syphon cup with acetone and completely emptying it, will be between 2½ and 3½ minutes.

PREPARATION OF REAGENTS.

9. Acetone shall be freshly distilled over anhydrous K_2CO_3, using the fraction 56–57° C.

10. Alcoholic KOH solution shall be of normal strength and shall be made freshly by dissolving the proper amount of KOH (purified by alcohol) in 95 per cent alcohol which has previously been distilled over KOH. The solution shall be allowed to stand for 24 hours and only the clear liquid used.

11. Ether shall be washed with three successive portions of distilled water and distilled, using the fraction 34–36° C.

12. Chloroform shall be pure and freshly distilled.

13. Carbon tetrachloride shall be pure and freshly distilled.

14. Reagents not otherwise specified shall be c.p. Water shall be distilled.

ACETONE EXTRACT.

15. Extract continuously with 60 cc. acetone for 8 hours, two 2-g. samples that have been prepared within 24 hours. Unite the extracts in a weighed flask, using hot chloroform to rinse the flasks. Distill off the reagents and dry the flask and contents for 4 hours at 95–100° C. Desiccate until cool and weight. Continue to dry for 2-hour periods until constant weight is obtained. In drying, place the flask on its side but at a sufficient angle from the horizontal so that the extract does not appreciably run down the side of the flask.

UNSAPONIFIABLE MATERIAL.

16. Add to the acetone extract 50 cc. alcoholic KOH solution, boil under a reflux condenser for 2 hours, and evaporate to dryness, removing all alcohol. Add 10 cc. water and 20 cc. ether; heat until the wax, etc., are in solution, cool, transfer to a separatory funnel, wash out the flask with warm water and then cool, finally with two 20-cc. portions of ether. The water volume should be 100 cc. and the ether at least 40 cc. Shake vigorously for 2 minutes, and allow the solutions to separate thoroughly. Draw off the aqueous solution into a second funnel, leaving in the first funnel the ethereal solution and any flocculent material that may be present. Again rinse the flask with 20 cc. ether and add it to the aqueous solution; shake vigorously for 2 minutes, and when separated draw off the aqueous solution and unite in the first funnel the ethereal solutions and any flocculent material. Repeat, shaking with 20 cc.

portions of ether until the extraction is complete, using at least 120 cc. ether. Wash the flask and the funnel, from which the ethereal solution has been taken, with water, until they are free from alkali, subsequently using this wash water to wash the ethereal solution. Continue washing with water until it has been washed twice after it shows no alkaline reaction. Retain with the ethereal solution any flocculent material. Filter the ethereal solution from the flocculent material, through a small pellet of extracted cotton, into a weighed flask, washing first with ether and subsequently with hot chloroform, using this to rinse the original flask and both separatory funnels. Evaporate the solvents and dry the extract to constant weight at 95 to 100° C.; desiccate until cool and weight.

HYDROCARBONS A.

17. Add 50 cc. absolute alcohol to the unsaponifiable material and warm until solution is as complete as possible. Cool the solution to -4 or $-5°$ C. and maintain at this temperature for 1 hour by packing the flask in a mixture of ice and salt. Filter out the waxy hydrocarbons, using a funnel packed with ice and salt, and apply suction if necessary. Wash the flask and filter with about 25 cc. of 95 per cent alcohol, which has been previously cooled in the same temperature. Catch the filtrate in a flask which is afterwards cooled to -4 or $-5°$ C. to make sure that all possible waxy hydrocarbons have been removed, and refilter if necessary. Dissolve the residue on the filter paper with hot chloroform, into the original flask. Evaporate the chloroform and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

HYDROCARBONS B.

18. Evaporate the alcohol from the flask containing the alcoholic soluble unsaponifiable material, add 25 cc. carbon tetrachloride and transfer to a separatory funnel. Shake with concentrated H_2SO_4, drain off the discolored acid and repeat with fresh portions of acid until there is no longer any discoloration. After drawing off all the acid, wash the carbon tetrachloride solution with repeated portions of water until all traces of acid

are removed. Transfer the carbon tetrachloride solution to a weighed flask; evaporate off the solvent and dry the flask to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

FREE SULFUR.

19. Add 2 g. KNO_3 to the aqueous solution and washings from the ethereal separation of the unsaponified material. Evaporate to dryness in a silver or nickel dish and heat to quiet fusion, avoiding contamination with sulfur fumes. Transfer with water to an evaporating dish, acidify with HCl, evaporate to dryness, and dehydrate silica. Add 2 cc. concentrated HCl, take up in water, filter and wash, making a volume of 200 cc. Heat to boiling and add slowly a slight excess of hot 10 per cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate the sulfur.

DEFINITION OF TERMS DESCRIBING COMPONENTS OF ACETONE EXTRACT.

20. The difference between the Acetone Extract and the Free Sulfur shall be called the Organic Extract.

21. The difference between the Organic Extract and the Unsaponifiable Material shall be called the Saponifiable Acetone Extract.

22. The sum of the Hydrocarbons A and B shall be called the total Waxy Hydrocarbons.

23. The difference between the Unsaponifiable Material and the Waxy Hydrocarbons shall be called Unsaponifiable Resins.

CHLOROFORM EXTRACT.

24. Extract continuously the residues from both of the acetone extractions (without necessarily removing the acetone that may be on them) for 4 hours with 60 cc. of chloroform, unite the extractions in a weighed flask, using hot chloroform to rinse the flasks. Distill off the solvent and dry the flask and contents for 2 hours at 95 to 100° C. Desiccate until cool and weigh. Continue to dry for 1-hour periods until constant weight is obtained. In drying, place the flask on its side but at a sufficient angle from the horizontal so that the extract does

not appreciably run down the side of the flask. (If it is needful to wait after the acetone extraction, before starting the chloroform extraction, the sample must be kept in a vacuum of at least 50 mm. of mercury.)

ALCOHOLIC-POTASH EXTRACT.

25. Dry the residue from the chloroform extraction at 50 to 60° C. until odor of chloroform can no longer be detected, unite residues from the two 2-g. samples in a 200 cc. Erlenmeyer flask. Add 100 cc. alcoholic KOH solution and boil for 4 hours under a reflux condenser. Filter the solution by decantation through an 11 cc. hardened filter paper into a beaker and wash twice, using each time 25 cc. hot absolute alcohol and then wash thoroughly with hot water. Wash any rubber on the filter paper back into the original flask and reserve this for the determination of the rubber hydrocarbons. Evaporate the solution to approximate dryness, take up in warm water and transfer to a separatory funnel. Acidify with 15 cc. of 5 normal HCl, using this to rinse the beaker. Add sufficient water to make the bulk of the solution 100 cc. When cool add 40 cc. ether, using it to rinse the beaker in 20 cc. portions. Shake the aqueous and ethereal solutions thoroughly. After complete separation, draw off the aqueous solution and treat in another separatory funnel, with a fresh 20 cc. portion of ether. Continue to shake the aqueous solution with fresh portions of ether until a colorless portion has been obtained, then shake out twice more. Unite the ethereal solutions and wash with successive additions of water, continuing twice after the water shows no acid reaction. Filter through a plug of extracted cotton into a tared flask, wash the filter and funnel with ether, evaporate the ether without boiling and dry the residue to constant weight at 95 to 100° C. Cool in a desiccator and weigh.

RUBBER HYDROCARBONS.

26. Add to the flask containing the rubber residue from the alcoholic potash extraction, sufficient water to make the total volume of the solution 125 cc. and then add 25 cc. concentrated hydrochloric acid. Heat for an hour at 97 to 100° C. Decant the supernatant liquid through a hardened filter paper

on a Buchner funnel 7 cm. diameter, using suction; wash the residue with 25 cc. hot water and decant. (While a Buchner funnel is recommended, it is permissible to use an 11 cm. hardened filter paper with platinum cone, in a 60-deg. funnel.) Perform this entire treatment with water and hydrochloric acid three times and save the first and second decantations for the "organic matter" test described in Section 33. The rubber at this stage should be white and practically free from black specks of undissolved fillers; if not, continue the acid treatment until the black specks disappear. (If carbon is present, all the particles of rubber will be grayish, bluish, or black, depending on the form and quantity of carbon used. Black specks in light particles of rubber usually indicate the presence of lead sulfide which must be removed to prevent the formation of lead sulfate on igniting the residue C.) Add 150 cc. hot water to the flask and let stand on a steam bath or hot plate for half an hour and decant through the filter paper, repeating until washings are free from chlorides. (See Section 33.) Transfer all the rubber in the flask to the filter paper and dry as much as possible by suction. Wash the rubber with 50 cc. of 95 per cent alcohol, using suction. Transfer the entire residue to a weighing bottle. Dry at 95 to 100° C. for an hour, cool in a vacuum desiccator under reduced pressure and weigh. Dry for a half hour, cool and weigh, repeating this process until either constant weight is reached or the weight starts to increase. Let this weight be represented by C. Determine the ash (E) on a portion (D) of this residue (C) and sulfur (H) on the remaining portion (G). Ttso determine the sulfur (F) on the ash (E). Perform the ash hAermination as described under ash in Rubber Residue and edl sulfur determinations as described under Total Sulfur. theen,

$$\text{Rubber hydrocarbons} = 100\,\frac{C}{4}\left(1-\frac{H}{C}-\frac{E-F}{D}\right)$$

expressed as a percentage of the total sample.

ASH IN RUBBER RESIDUE.

27. Place about 1/2 g. (D) of residue C into a weighed porcelain crucible and heat gently, gradually driving off the

volatile matter. When the crucible has ceased to smoke, raise the temperature gradually to between 450 and 500° C., until all organic matter has been burned away, which is usually indicated by the ash becoming white. (an electric muffle furnace with pyrometer is recommended for this purpose.) Cool in a desiccator and weigh, the weight of ash being represented by *E* in the formula for rubber hydrocarbons. Make sulfur test on ash by the method described under Total Sulfur. If, however, the ash (*E*) is not over 0.08 *D*, the determination of sulfur in the ash may be omitted, and *F* assumed to be zero.

TOTAL SULFUR.

28. Mix a 0.5-g. sample with 4 g. Na_2O_2 and 6 g. K_2CO_3 in a dry 15-cc. iron crucible. Cover and heat gradually until the mixture fuses, proceeding cautiously, as rapid heating will cause an explosion, and then bring to quiet fusion for 15 to 20 minutes. Apply the heat so as to avoid contamination with sulfur fumes. Rotate the crucible while the melt solidifies. When cool, put crucible and cover into a casserole containing 200 cc. of water; add 5 to 10 cc. bromine water and boil until the melt is dissolved. Allow the precipitate to settle, decant the liquid through a thick filter and wash the residue with hot water. Acidify the filtrate with HCl, evaporate to dryness and dehydrate silica; add 2 cc. concentrated HCl, take up in water, filter and wash, making the total volume about 100 cc. Heat to boiling and add slowly a slight excess of hot 10 per cent $BaCl_2$ solution. Allow to stand over night, filter, wash, ignite, weigh the $BaSO_4$ and calculate to sulfur.

SPECIFIC GRAVITY.

29. The specific gravity shall be the ratio of the weight of a given volume of the rubber to the weight of an equal volume of water, both at 20° C. Cut strips of the largest applicable size from the conductor and use about 5 g. for the sample. Determine the specific gravity in the usual manner by means of a specific gravity bottle. Care must be taken that no air bubbles adhere to the sample.

CHECKS.

30. Specific gravity determinations shall check within 0.01. The other duplicate determinations shall check within the following limits expressed as percentages of the original sample.

DETERMINATION.	CHECK.
Acetone extract	0.10
Saponifiable acetone extract	0.10
Unsaponifiable resins	0.10
Waxy hydrocarbons	0.10
Free sulfur	0.05
Chloroform extract	0.10
Alcoholic potash extract	0.10
Rubber hydrocarbons	0.20
Total sulfur	0.10

INTERPRETATION.

31. The rubber shall be considered to be the sum of the rubber hydrocarbons, saponifiable acetone extract, unsaponifiable resins and chloroform and alcoholic potash extracts, expressed as percentages. If the chloroform extract is over 3.0 per cent of the rubber so calculated, subtract the excess from the rubber. If the KOH extract is over 1.8 per cent of the rubber as first calculated, subtract this excess also from the rubber.

RED LEAD.

32. Dissolve 1 g. of the sample in 75 cc. xylol at a temperature of about 100° C. When the rubber is dissolved, the absence of any red particles indicates the absence of red lead. If red particles are present, filter the solution into a Gooch crucible and wash thoroughly with benzol, acetone and alcohol successively. Remove the felt and residue to a distilling flask, add HCl, and distill over the chlorine liberated by the lead peroxide, absorbing the gas in a solution of KI and starch. Not more than 0.1 cc. N/10 thiosulfate shall be required to titrate the iodine liberated.

ORGANIC FILLERS.

33. Transfer the first and second decantations of the hydrochloric acid solutions to a carefully cleaned porcelain dish and

add 20 cc. concentrated sulfuric acid. Place dish on steam bath or hot plate to drive off water and hydrochloric acid. A pronounced charring of the residue indicates the presence of organic matter soluble in water or hydrolyzed by hydrochloric acid. Examine filter paper and rubber while decanting acid solution and washing free of chlorides. Some types of organic fillers not removed by water and hydrochloric acid, would be plainly visible at this point. Place a small portion of residue *C* under a microscope and examine for fibrous and other characteristic organic material. If organic fillers are indicated and not clearly proven by this test, place 1 g. of the original sample in a beaker, add 50 cc. xylol and heat on hot plate until the rubber is dissolved. Decant xylol solution and wash residue with ether several times by decantation. Dry residue and examine under the microscope.

STATEMENT OF RESULTS.

34. The results of the analysis shall be stated in the following form:

	PER CENT.
Acetone extract	-------
Saponifiable acetone extract	-------
Unsaponifiable resins	-------
Waxy hydrocarbons	-------
Free sulfur	-------
Chloroform extract	-------
Alcoholic potash extract	-------
Total sulfur	-------
Rubber	-------
Color of acetone extract (60 cc. vol.)	-------
Fluorescence in acetone extract solution (present or absent)	-------
Hydrocarbons A (consistency and color)	-------
Hydrocarbons B (solid or liquid)	-------
Color of chloroform extract (60 cc. vol.)	-------
Carbon (present or absent)	-------
Red lead (present or absent)	-------
Specific gravity	-------

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PHILADELPHIA, PA., U. S. A.
AFFILIATED WITH THE
INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE TESTS
FOR
PAINT THINNERS OTHER THAN TURPENTINE.

Serial Designation: D 28 – 16 T.

Criticisms of these Tentative Tests are solicited and should be directed to Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 129 York Street, Brooklyn, N. Y.

Specific Gravity.

The specific gravity may be determined by a hydrometer, Westphal balance, or pyknometer, provided these instruments are verified. The observations shall be taken with the sample at 15°.56 C. (60° F.) and compared with water at the same temperature.

Distillation.

Apparatus.—The general arrangement of the apparatus is shown in Fig. 1.

Flask.—The flask used shall be the Standard Engler flask as described in the various standard works upon petroleum, such as Redwood, Holde, etc.

"Engler employs a globular flask 6.5 cm. in diameter, with a cylindrical neck 1.6 cm. in internal diameter and 15 cm. in length, from the side of which a vapor tube 10 cm. in length extends at an angle of 75 deg. downwards to the condenser.

The junction of the vapor tube with the neck of the flask should be 9 cm. above the surface of the oil when the flask contains its charge of 100 cc. of oil. The observance of the prescribed dimensions is considered essential to the attainment of uniformity of results."[1]

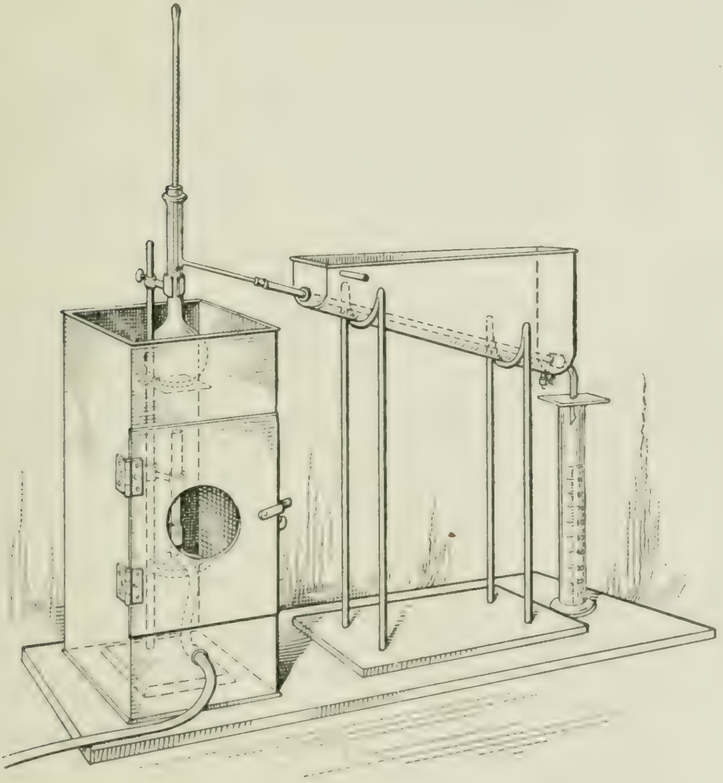

FIG. 1.—Distillation Apparatus.

The flask shall be supported in a ring of asbestos having an opening $1\frac{1}{4}$ in. in diameter in its center.

The flask, burner, etc., shall be surrounded by a shield.

Condenser.—The condenser shall consist of a tube of thin brass of $\frac{1}{2}$ in. internal diameter, 22 in. in length, set at an angle of 75 deg. with the flask and surrounded by a water jacket of the trough type. The lower end of the condenser shall be cut off at an acute angle and shall be curved down for a length of 3 in., so as to project at least ½ in. into the 100-cc. cylinder used as a receiver.

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[1] Redwood, 3d edition, Vol. 2, p. 205 (1913).

A cover (pasteboard) should be placed over the top of the cylinder and surrounding the condenser tube.

Thermometer.—The thermometer used shall conform to the following specifications:

The thermometer shall be graduated from 0 to 400° C. in intervals of 1° C. There shall be a small reservoir above the 400° mark. The thermometer shall be finished at the top with a small glass ring. The stem shall be made of enamel-backed thermometer tubing, but not of Jena 16^{III} glass. The bulb shall be made of Jena 16^{III}, Corning normal, or Jena or Corning borosilicate glass.

Every fifth graduation shall be longer than the intermediate ones, and the marks shall be numbered at every interval of 10°. The graduation marks shall be clear cut and fine, and the numbering clear cut and distinct. The thermometer shall be filled above the mercury with an inert gas, which will not act chemically on or contaminate the mercury. The pressure of the gas shall be sufficient to prevent separation of the mercury column at all temperatures of the scale, but the upper reservoir shall be large enough so that the pressure will not become excessive at the highest temperature.

The thermometer shall be thoroughly annealed before the final filling. It shall be pointed for use at full immersion.

Each thermometer shall be provided with a suitable case. A serial number for identification and the word "Distillation" shall be engraved on the stem.

All material and workmanship shall be of the best grade.

The maximum error from 0 to 200° C. shall not exceed 0°.5 C.; from 200 to 300° C., shall not exceed 1° C.; and from 300 to 400° C., shall not exceed 2° C.

The thermometer shall conform to the following dimensions:

Total length, max., mm.	385
Diameter of stem, mm.	5.5 – 7.0
Diameter of bulb, mm.	5.5 – 7.0
Diameter of capillary, min., mm.	0.1

Length of bulb, mm	11 - 15
Distance, 0° to bottom of bulb, mm	25 - 35
Distance, 0 to 400° mark, mm	280 - 300

The thermometer shall be inserted through a tight fitting cork in the neck of the flask, so that the top of the thermometer bulb will be on a level with the bottom of the side outlet in the neck of the flask and in the center of the neck.

Method of Distillation.—The flask, connected with the condenser, shall be filled with 100 cc. of the thinner at 60° F., which shall be measured in the 100-cc. receiving cylinder. The same cylinder may be used without drying as the receiving vessel for the distillate. The flask shall be heated directly by a suitable burner.

The distillation shall proceed at the rate of not less than 4 nor more than 5 cc. per minute into the receiving cylinder. The temperature at which the first drop leaves the lower end of the condenser shall be considered the initial boiling point.

Readings of the quantity in the receiver shall be taken when the next 10° point is reached, and for every even 10° thereafter. For example, if initial boiling point occurs at 144° C., then the first reading of the quantity in the receiver shall be made at 150° C., and thereafter at 160°, 170°, etc.

The distillation shall be continued until the point is reached where the last drop is vaporized, when a puff of white vapor usually appears in the bottom of the flask. The temperature at this point shall be considered the end or dry point of distillation.

The total yield of distillate shall not be less than 97 per cent.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE TESTS
FOR
SHELLAC.

Serial Designation: D 29 – 16 T.

Criticisms of these Tentative Tests are solicited and should be directed to Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 129 York Street, Brooklyn, N. Y.

DETERMINATION OF ROSIN IN SHELLAC.

Solutions Required.—The solutions required are one of iodine monochloride containing 13 g. of iodine per liter, in glacial acetic acid that has a melting point of 14.7 to 15° C. and is free from reducing impurities; and another of sodium thiosulfate, made by dissolving 24.83 g. of the pure salt in a liter of water. In addition to these solutions there is required a quantity of acetic acid of the same strength as that used for making the solution of iodine monochloride. Pure chloroform and starch are also necessary.

The preparation of the iodine-monochloride solution presents no great difficulty, but it shall be done with care and accuracy in order to obtain satisfactory results. There shall be in the solution no sensible excess either of iodine or more particularly of chlorine, over that required to form the monochloride. This condition is most satisfactorily attained by dissolving in the whole of the acetic acid to be used the requisite quantity of iodine, using a gentle heat to assist the solution, if it is found necessary. Set aside a small portion of this solution, while pure, and pass dry chlorine into the remainder until the halogen content of the whole solution is doubled. Ordinarily it will be found that by passing the chlorine into the main part of the solution until the characteristic color of free iodine has just been discharged, there will be a slight excess of chlorine, which is corrected by the addition of the requisite amount of the unchlorinated portion until all free chlorine has been destroyed. A slight excess of iodine does little or no harm, but excess of chlorine must be avoided.

Method.—Introduce 0.2 g. of ground shellac into a 250-cc. dry bottle of clear glass with a ground-glass stopper, add 20 cc. of glacial acetic acid (melting point 14.7 to 15° C.) and warm the mixture gently until solution is complete (except for the wax). A pure shellac is rather difficultly soluble; solution is quicker according to the proportion of rosin present. Ten cubic centimeters of chloroform are added and the solution is cooled to 21 to 24° C. The temperature should be held well within these limits during the test. Twenty cubic centimeters of Wijs solution are added from a pipette, having a rather small delivery aperture. The bottle is closed and placed in a dark place, and the time noted. It is convenient to keep the bottles during the test partly immersed in water which should be kept as nearly as possible between 22 and 23° C.

Pure shellac will scarcely alter the color of the Wijs solution. If in small amount, rosin will produce a slowly appearing red-brown color. In large amount, rosin causes an immediate coloration, increasing in intensity as time passes. After 1 hour, 10 cc. of 10-per-cent potassium-iodide water solution are added. The solution is immediately titrated with the sodium-thiosulfate solution; 25 or 30 cc. may be run in immediately, unless the shellac is very impure, and the remainder gradually, with vigorous shaking. Just before the end, a little starch solution is added. The end point is sharp, as the reaction products of shellac remain dissolved in the chloroform; any color returning after ½ minute or so is disregarded.

A blank determination should be run with 20 cc. of Wijs solution, 20 cc. of acetic acid, 10 cc. of chloroform, and 10 cc. of 10-per-cent potassium iodide solution. The blank is necessary on account of the well-known effect of temperature changes on the volume, and possible loss of strength of the Wijs solution.

In the case of grossly adulterated samples, or in the testing of pure rosin, it is necessary to use, instead of 0.2 g. of material, a smaller amount, say 0.15 g. or even 0.1 g., in order that the excess of iodine monochloride may not be too greatly reduced, since the excess of halogen is one of the factors in determining the amount of absorption. It is safe to say that in case less than 25 cc. of the thiosulfate solution are required, another test should be made, using a smaller amount of the shellac to be tested.

In weighing shellac, some difficulty is at times experienced on account of its electrical properties. In very dry weather it may be found that the necessary handling to prepare it for weighing has electrified it, and that it may be necessary to leave it on the balance pan at rest for a few minutes before taking the final weight.

No pure shellacs show a higher iodine absorption than 18. As shellac is relatively a high-priced material and as the variation between its highest and lowest figure is not great, it is recommended that 18 should be taken as the standard figure for shellac, determined by the method above described.

As it is an accepted principle that a standard method should be so devised that its inaccuracies shall work in the direction of favoring the seller rather than of condemning too severely the article sold, it is recommended that the value for the iodine number of rosin be taken as 228. The results of using in this method the value 18 as the iodine number of shellac and 228 as the number of rosin, may be that a slightly lower percentage of rosin, under some circumstances, will be found than that which is actually present.

The percentage of rosin is determined as follows:

Iodine number of shellac = 18
" " " rosin = 228
" " " mixture = X

$$\text{Percentage of rosin} = 100\,\frac{(X-18)}{(228-18)}$$

INSOLUBLE TEST FOR SHELLAC.

The separation of the soluble from the insoluble portion of the lac is made by extracting approximately 5 g. of the lac in a paper cartridge, which is held in a tube provided with a siphon as in the Knoefler extraction apparatus, and is heated by the vapors of the alcohol which pass around the tube and are then condensed by a return condenser to fall as liquid upon the shellac to be extracted. The siphon tube should be slightly larger than the cartridge, which should be supported so that it does not rest directly on the bottom.

The most convenient apparatus for carrying out the process is illustrated in Fig. 1. It consists of a wide-neck flask in which is suspended a metal return condenser. From the lower part of this condenser is hung a siphon tube of the Knoefler type. A Schleicher and Schuell extraction cartridge, No. 603, 26 mm. in diameter by 60 mm. high, is used in a siphon tube of such a size that the top of the cartridge is just above the upper curve of the siphon, the paper thimble being cut down if necessary. It is supported on three indentations in the glass so

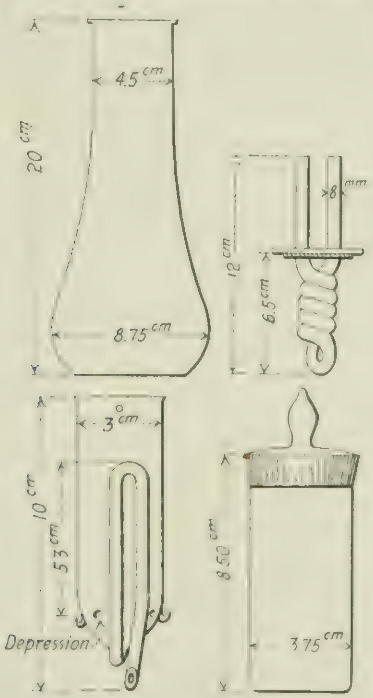

FIG. 1.—Apparatus for the Insoluble Test for Shellac.

that there is a little space underneath and around the cartridge to allow of a free flow of liquid. To insure the complete extraction of all matters soluble in alcohol in the cartridge itself, it should be thoroughly extracted with 99.5-per-cent methyl alcohol before use. It is then placed in a glass-stoppered weighing bottle and dried to constant weight in an air bath at 100° C. A sample of approximately 5 g. of the pulverized lac is placed in the cartridge, which is then transferred to the extraction apparatus. The cartridge is filled with cold alcohol of the character described to a point just below the upper curve in the siphon. The cold alcohol is allowed to act upon the lac for 1 hour before the extraction commences.

During the extraction the alcohol is kept boiling briskly. The rate of extraction may be controlled by the use of an electric stove of the Simplex type, $4\frac{1}{2}$ in. in diameter, and using the full current of 2.2 amperes at 110 volts. The volume of methyl alcohol in the flask should be 125 cc. This is in addition to the alcohol required to fill the siphon. The flask should be protected from drafts. Under these conditions the tube will siphon over about 33 times in 1 hour. The condenser should be able to return all the alcohol volatilized during the vigorous boiling of the contents of the flask, the object being to effect the maximum extraction during the specified time.

The color is removed by the end of the first hour in practically every case and in order to eliminate any variations due to difference of opinion as to the exact time when the color has disappeared, we recommend that the total extraction period be limited to exactly 2 hours, time being taken from the moment when the first siphon tube of alcohol has passed over. The cartridge after extraction is placed in the weighing bottle, dried to constant weight at 100° C. and the whole weighed.

The weight of the residue insoluble in alcohol thus obtained, divided by the weight of the sample, and this quotient multiplied by 100, is the percentage of alcohol-insoluble matter in the lac.

In some quarters a similar test is known as the "refraction" of the lac.

It will be noted that there are three depressions in the lower part of the glass extraction thimble to hold the cartridge above the bottom. This is very necessary for the reason that during the early part of the extraction, a very free flow must be maintained to prevent the blocking of the siphon with the wax, which, though readily soluble in hot alcohol, is with difficulty soluble in cold alcohol. The object in filling the cartridge with cold alcohol, before starting the extraction proper, is to allow the resin and some of the wax to dissolve at a low temperature. If the higher temperature of the boiling alcohol were immediately applied it would fuse the resin into a lump and render the extraction difficult. The first few drops of distilled alcohol which fall into the cartridge will cause the extract to siphon over, thus eliminating the bulk of the resin at the start.

DETERMINATION OF MOISTURE IN BLEACHED SHELLAC.

Both orange and bleached shellac give off volatile matter at temperatures approaching 100° C. Bleached shellac alters chemically at these temperatures, losing its solubility in alcohol. For these reasons the usual methods of determining moisture by heating in the air bath at 100 to 110° C. are not applicable in the analysis of shellac.

Sampling.—Bleached shellac is sold in three forms, as hanks or bars containing approximately 25 per cent of water, as ground bleached in pulverized form with about the same water content, and as bone-dry or kiln-dried shellac. The latter is prepared by drying the ground-bleached shellac in the air or in vacuum driers at moderate temperatures. It may contain, depending upon the completeness of the drying and weather conditions, up to 10 per cent or more of water.

In sampling bone-dry or kiln-dried bleached shellac a fairly large portion (about 1 lb.) should be taken from different parts of the barrel and finely ground by running quickly through a coffee mill. No attempt shall be made to sieve it. It is rapidly mixed and transferred to a Mason jar provided with a screw cap and rubber ring seal. The jar should not be more than two-thirds full, leaving room for a thorough mixing by shaking the contents. It shall be kept in a cool place and tested as promptly as possible. If too warm the shellac may become partly caked, in which case the lumps shall be broken up by shaking the bottle.

In sampling bars or hanks it is recommended that a whole hank be taken. It should be crushed and ground as rapidly as possible. Ground-bleached shellac may be treated as above, bearing in mind that the large amount of moisture present makes rapid handling imperative.

Method No. 1.—From 5 to 10 g. of the sample should be weighed in flat-bottom dishes about 4 in. in diameter or in watch glasses ground to fit and provided with a clamp. The contents of the dish should be spread out in a thin layer to expose as large a surface as possible. The shellac is then placed in a desiccator freshly filled with concentrated sulfuric acid. The desiccator is exhausted by a vacuum pump as completely as possible. With a good vacuum (3 mm. pressure or better) constant weight will be obtained in between 24 and 48 hours.

Absolutely dry shellac is quite hygroscopic and the final weight should be taken as rapidly as possible.

Method No. 2.—The same results may be obtained by drying the shellac in a well-ventilated air bath from 3 to 6 hours at 100 to 110° F. (38 to 43° C.). One or two electric light bulbs provide a convenient source of heat. The temperature should not be allowed to rise above 43° C., otherwise sintering may occur and retard drying. With poorly ventilated ovens the drying may take much longer. Completeness of drying should be ascertained by continuing the treatment to constant weight.

It is recommended that analysts check the accuracy of results obtained in the oven by comparison with a test made in a vacuum desiccator before relying exclusively on the oven.

NOTE.

When the determination of alcohol insoluble matter in bleached shellac is required, the sample shall be dried if in the form of bars or ground bleached, as the water present dilutes the alcohol to a point where solution may not be complete. Prolonged heating at the temperatures of 38 to 43° C. stated above may render the shellac partly insoluble, and it is recommended that in preparing shellac for this determination a separate portion be dried by exposure to the air in a thin layer, without the application of heat.

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TENTATIVE TEST
FOR
DETERMINATION OF APPARENT SPECIFIC GRAVITY OF HOMOGENEOUS COARSE AGGREGATES.[1]

Serial Designation: D 30 – 16 T.

Criticisms of this Tentative Test are solicited and should be directed to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

The apparent specific gravity shall be determined in the following manner:

1. A properly selected sample which will pass a 2.54-cm. (1-in.) circular opening and which will not pass a 1.27-cm. ($\frac{1}{2}$-in.) circular opening, and approximately cubical or spherical in shape, shall be dried to constant weight at a temperature between 100 and 110° C. (212 and 230° F.).

2. The dried sample shall be suspended in air by a fine wire or thread from a scale or balance and weighed in air to 0.01 g., which weight shall be recorded as weight *A*.

3. It shall then be immersed, for not less than 10 minutes, in clear water having a temperature between 15 and 25° C.

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[1] Attention is called to the distinction between apparent specific gravity and true specific gravity. Apparent specific gravity includes the voids in the specimen and is therefore always less than or equal to, but never greater than, the true specific gravity of a material.

(60 and 77° F.) until no air bubbles appear on the surface of the sample.

4. After all air bubbles shall have been removed from the surface and after the scales have been balanced, the sample shall be allowed to remain immersed for 1 minute, and if any change in weight takes place, the sample shall remain in water until the balance remains constant within 0.01 g. for 1 minute. This weight shall be recorded as weight B.

5. After weight B has been obtained, the sample shall be removed immediately from the water, the surface water shall be wiped off with a towel or filter paper, and the wet sample shall be promptly weighed in air. This shall be recorded as weight C.

6. The apparent specific gravity of the sample shall be calculated by dividing the weight of the dry specimen (A) by the difference between the weights of the saturated specimen in air (C) and in water (B) as follows:

$$\text{Apparent specific gravity} = \frac{A}{C-B}.$$

7. The apparent specific gravity of the material shall be the average of three determinations, made on three different samples, according to the method described above.

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TENTATIVE TESTS
FOR
AUTOMOBILE TIRE FABRICS.

Serial Designation: D 31 – 16 T.

Criticisms of these Tentative Tests are solicited and should be directed to Mr. W. D. Hartshorne, Chairman of Committee D-13 on Textile Materials, Methuen, Mass.

I. GENERAL REQUIREMENTS.

General Requirements.

1. Tests upon automobile tire fabrics shall be made in accordance with the Tentative General Methods for Testing Cotton Fabrics (Serial Designation: D 39–16 T),[1] with the modifications specified below.

II. SPECIAL REQUIREMENTS.

(*A*) *Number of Threads per Inch.*

Number of Threads per Inch.

2. (*a*) The number of threads per inch or count of the fabric shall be determined by counting a space of 10 in. in at least five different places in the roll.

(*b*) The average of the five determinations shall be the count.[2]

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[1] See p. 572.—ED.

[2] A 10-in. steel "count scale" similar to an engineer's triangular scale, graduated with teeth one inch apart on one edge, and to the specifications of the cloth on the others,—for example, 23 teeth per inch on the second and 23 teeth per inch with each inch indicated on the third edge, as shown in Fig. 1 will be found convenient, rapid, and accurate for making this measurement when used in the manner of a machinist's thread gage. The chairman will furnish any information desired regarding this count scale.

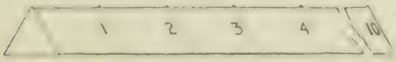

FIG. 1.

(*B*) *Strength.*

Strength. 3. (*a*) The strength of the fabric shall be determined by the "Strip Method."

(*b*) The test specimens shall be tested in the "dry condition" as defined in Section 2 of the Tentative General Methods for Testing Cotton Fabrics. They shall be taken one at a time from the drying oven and immediately securely clamped in the jaws of the machine, care being taken to see that the threads being tested are parallel to the direction of the pull and the cross threads are perpendicular to the line of pull.

(*c*) The breaking stress should be obtained within 30 seconds after taking a specimen from the oven.

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TENTATIVE TESTS
FOR
COTTON FABRICS FOR USE IN HOSE, BELTING AND SIMILAR ARTICLES.

Serial Designation: D 32 – 16 T.

Criticisms of these Tentative Tests are solicited and should be directed to Mr. W. D. Hartshorne, Chairman of Committee D-13 on Textile Materials, Methuen, Mass.

I. GENERAL REQUIREMENTS.

General Requirements. 1. Tests upon fabrics for use in hose, belting and similar articles shall be made according to the Tentative General Methods for Testing Cotton Fabrics (Serial Designation: D 39-16 T),[1] with the modification specified below.

II. SPECIAL REQUIREMENTS.

Strength. 2. The strength shall be determined by the "Grab Method," and the specimens when tested shall be at "standard condition" as defined in Section 3 of the Tentative General Methods for Testing Cotton Fabrics.

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[1] See p. 572.—Ed.

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TENTATIVE TESTS

FOR

COTTON FABRICS FOR USE IN BAGS AND BAGGING MATERIAL.

Serial Designation: D 33 – 16 T.

Criticisms of these Tentative Tests are solicited and should be directed to Mr. W. D. Hartshorne, Chairman of Committee D-13 on Textile Materials, Methuen, Mass.

I. GENERAL REQUIREMENTS.

General Requirements. 1. Tests upon fabrics for use in bags and bagging material shall be made according to the Tentative General Methods for Testing Cotton Fabrics (Serial Designation: D 39–16 T),[1] with the modifications specified below.

II. SPECIAL REQUIREMENTS.

(*A*) *Determination of Dimensions of Bags.*

Dimensions. 2. The dimensions of a bag shall be determined by turning it wrong side out, laying it smooth and flat without stretching and measuring with a stiff rule the distance between the seams, the seam and the crease, or between the creases, as the case may be.

(*B*) *Width of Cloth.*

Width. 3. The width of the cloth at any place shall be measured at right angles to the selvages when laid open on a flat horizontal surface and smoothed out by hand but not stretched.

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[1] See p. 572.—Ed.

(C) *Preparation of Test Specimens.*

Test Specimens.

4. Test pieces shall be cut approximately as shown in Fig. 1. For the strip method they shall be 8 in. long by $1\frac{1}{2}$ in. wide and for the grab method 5 in. long by 2 in. wide.

(D) *Strength.*

Strength.

5. (*a*) The strength of the fabric shall be determined by the "Grab Method" or "Strip Method" as specified.

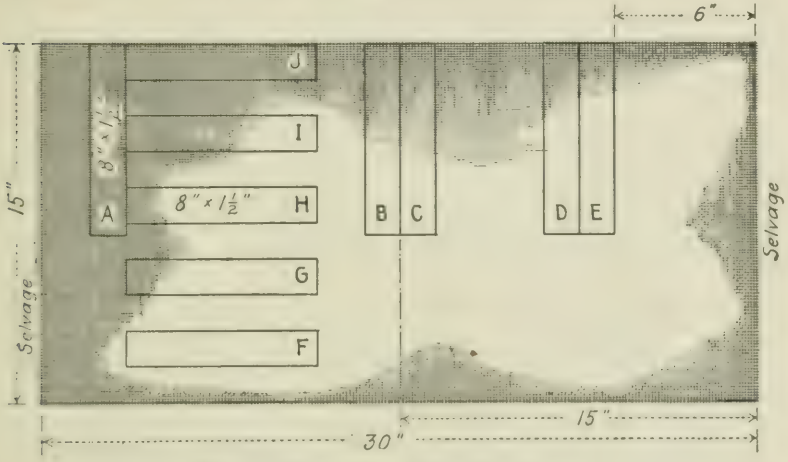

FIG. 1.—Location of Test Specimens.

(*b*) The test specimens shall be tested in the "dry condition" as defined in Section 2 of the Tentative General Methods for Testing Cotton Fabric. They shall be taken one at a time from the drying oven and immediately securely clamped in the jaws of the machine, care being taken to see that the threads being tested are parallel to the direction of the pull and the cross threads are perpendicular to the line of pull.

(*c*) The breaking stress should be obtained within 30 seconds after taking a specimen from the oven.

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TENTATIVE METHODS
FOR
ROUTINE ANALYSIS OF WHITE PIGMENTS.

Serial Designation: D 34 – 15 T.

Criticisms of these Tentative Methods are solicited and should be directed to Mr. G. W. Thompson, Secretary of Committee D-1 on Preservative Coatings for Structural Materials, 129 York Street, Brooklyn, N. Y.

I. METHOD FOR VERY SMALL AMOUNTS OF IRON.

Lead Pigments.—Treat sample with HNO_3 (1 : 1) in usual manner, dilute with H_2O, add H_2SO_4 to precipitate bulk of lead (not necessary to evaporate down); cool, filter, wash with 1 to 2 per cent of H_2SO_4, make filtrate just alkaline with NH_4OH, then just acid with dilute HNO_3, determine iron colorimetrically by the thiocyanate method, using same amounts of reagents in preparing standards. If sample contains insoluble matter, filter out and wash with hot water till Pb-free, and to filtrate add H_2SO_4 and proceed as given. The insoluble is ignited, treated with HF and H_2SO_4 in usual manner, brought into solution (filter out any $BaSO_4$), and added to filtrate from $PbSo_4$. If necessary, solution may be made up to volume and aliquots taken. Copper, if present, must be removed by precipitating the Fe with NH_4OH, filtering, washing, redissolving $Fe(OH)_3$ and proceeding as above.

Other Pigments.—Treat as above, omitting the addition of H_2SO_4.

II. GENERAL METHOD.

"Volume" or "apparent" specific gravity shall be determined by the Scott volumeter. True specific gravity shall be determined by Thompson's[1] method, or by means of a 50-cc. pyknometer, using c. p. benzene and 10 to 20 g. of pigment.

BASIC CARBONATE OF LEAD.

Total Lead (Gravimetric).—Dissolve 1 g. in 20 cc. of HNO_3 (1:1) in a covered beaker, heating till all CO_2 is expelled; wash off cover, add 20 cc. of H_2SO_4 (1:1) and evaporate to fumes of SO_3, cool, add about 150 cc. of water and 150 cc. of ethyl alcohol; let stand in *cold* water 1 hour, filter on a Gooch crucible, wash with 95-per-cent ethyl alcohol, dry at 110° C., and weigh $PbSO_4$; calculate to PbO or to basic carbonate.[2] Instead of determining the lead as sulfate, the sample may be dissolved by boiling with acetic acid; then dilute to about 200 cc. with water, make alkaline with NH_4OH, then acid with acetic acid, heat to boiling and add 10 to 15 cc. of a 10-per-cent solution of potassium dichromate; heat till the yellow precipitate assumes an orange color. Let settle and filter on a Gooch crucible, washing by decantation with hot water till the washings are colorless finally transferring all of the precipitate. Then wash with 95-per-cent ethyl alcohol and then ether; dry at 110° C. and weigh $PbCrO_4$. (Any insoluble matter should be filtered out before precipitating the lead.)

Total Lead (Volumetric).—Dissolve 0.5 g. of sample in 10 cc. of concentrated hydrochloric acid, boil till solution is effected, cool, dilute to 40 cc., neutralize with ammonium hydroxide. Add acetic acid until distinctly acid, dilute to 200 cc. with hot water, boil and titrate with ammonium molybdate as follows:

Dissolve 4.25 g. of ammonium molybdate in water and make up to one liter. To standardize this solution, dissolve about 0.2 g. of pure lead foil in nitric acid (pure PbO or $PbSO_4$ may also be used), evaporate nearly to dryness, add 30 cc. of water, then 5 cc. H_2SO_4 (sp. gr. 1.84), cool, and filter. Drop filter with $PbSO_4$ into a flask, add 10 cc. concentrated HCl, boil till completely disintegrated, add 15 cc. of HCl, 25 cc. of water, and NH_4OH till alkaline. Acidify with acetic acid, dilute to 200 cc. with hot water and boil. Titrate, using an outside indicator of one part of tannic acid in 300 parts of water.

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[1] *Proceedings*, Am. Soc. Test. Mats., Vol. XIII, p. 407 (1913).

[2] This method of weighing lead sulfate is not accurate in the presence of calcium compounds.

It should be noted that when calcium is present, it forms a more or less insoluble molybdate, and results are apt to be high. With samples containing less than 10 per cent of lead, the lead should be precipitated as $PbSO_4$, filtered, redissolved and titrated as in the process of standardizing.

Carbon Dioxide.—Determine by evolution with dilute hydrochloric acid absorbing in soda-lime or KOH solution. Calculate CO_2 to $PbCO_3$, subtract PbO equivalent from total PbO and calculate residual PbO to $Pb(OH)_2$.

Acetic Acid.[1]—Place 18 g. of the pigment in a 500-cc. flask, add 40 cc. of sirupy phosphoric acid, 18 g. of zinc dust and 50 cc. of water. Connect to a straight Liebig condenser, apply heat and distill down to a small bulk. Then pass steam into the flask until it becomes about half full of condensed water, shut off the steam and distill down to a small bulk—this operation being conducted twice. To the total distillate which was collected in a larger flask add 1 cc. of sirupy phosphoric acid, connect to a Liebig condenser, using a spray trap, and distill to a small volume—about 20 cc. Pass steam through till about 200 cc. of water condense in the distillation flask, shut off steam and continue the distillation. These operations of direct and steam distillations are conducted until 10 cc. of the distillate require only one drop of 0.1 N alkali to give a change in the presence of phenolphthalein. Then titrate the total distillate with 0.1 N sodium hydroxide and phenolphthalein and calculate the total acidity as acetic acid. It will be found convenient to titrate each 200-cc. portion of the distillate as collected.

Metallic Lead.[1]—Weigh 50 g. of the sample into a 400-cc. beaker, add a little water and add slowly 60 cc. of 40-per-cent acetic acid and after effervescence has ceased, boil on hot plate. Fill the beaker with water, let settle, and decant the clear solution. To the residue add 100 cc. of a mixture of 360 cc. of strong NH_4OH, 1080 cc. of water, 2160 cc. of 80-per-cent acetic acid and boil until all solution is complete. Fill beaker with water, let settle and decant the clear solution. Collect residue on a watch glass, floating off everything but metallic lead. Dry and weigh. Result × 2 = percentage of metallic lead in sample.

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[1] Thompson's Method, *Journal*, Soc. Chem. Ind., Vol. 24, p. 487 (1905).

The following method of A. N. Finn (unpublished) gives total basicity of a pure white lead: Place 2 g. of pigment in an evolution flask, add a little CO_2-free water, connect up to the separatory funnel and condenser (Knorr type), add through the funnel, finally washing down, 100 cc. of N/4 nitric acid, boil and absorb the CO_2 in soda-lime tube in usual manner (having H_2SO_4 and $CaCl_2$ drying tubes in train) and weigh. To the solution in the evolution flask, add about 20 cc. of neutral sodium-sulfate solution and titrate with N/4 sodium-hydroxide solution (carbonate-free), using phenolphthalein. CO_2 is calculated to $PbCO_3$. The amount of N/4 acid corresponding to the CO_2 is calculated and deducted from the total amount of N/4 acid neutralized by the sample and the difference calculated to combined H_2O, from which $Pb(OH)_2$ is computed.

BASIC SULFATE OF LEAD.[1]

Determination of Total Lead.—Dissolve 1 g. of the sample in 100 cc. of a mixture consisting of 125 cc. of 80-per-cent acetic acid, 95 cc. of NH_4OH (sp. gr. 0.90) and 100 cc. of water. Add the solution while hot and dilute with about 50 cc. of water, boil until sample is dissolved. Dilute to 200 cc. and titrate with standard ammonium-molybdate solution as described under basic carbonate of lead. The ammonium-molybdate solution contains about 8.67 g. per liter and is standardized against pure lead foil, pure PbO or pure $PbSO_4$.

Determination of Total Zinc.—Boil 1 g. of the sample with 30 cc. of water, 4 g. of NH_4Cl and 6 cc. of concentrated HCl (some $PbSO_4$ or $PbCl_2$ may not dissolve). Dilute to 200 cc. with hot water, add 2 cc. of a saturated solution of sodium thiosulfate and titrate with a standard solution of potassium ferrocyanide in usual manner. Calculate the zinc to ZnO,[2] as follows:

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[1] J. A. Schaeffer's Method, *Journal of Industrial and Engineering Chemistry*, Vol. 6, p. 200 (1914), may be used.

[2] It would probably be more accurate to remove total lead as $PbSO_4$ and titrate the zinc in the filtrate after adding NH_4OH and HCl in usual manner.

99.70[a] − percentage of ZnO found = percentage of lead constituents;

then

$$\frac{\left(\frac{\text{Molecular weight PbSO}_4}{\text{Atomic weight Pb}} \times \text{Percentage of Pb found}\right) - \text{Percentage of Pb constituents}}{\frac{\text{Molecular weight PbSO}_4 - \text{Molecular weight PbO}}{\text{Molecular weight PbO}}} = \text{percentage of PbO present.}$$

$$\frac{\left(\frac{\text{Molecular weight PbO}}{\text{Atomic weight Pb}} \times \text{Percentage of Pb found}\right) - \text{Percentage of Pb constituents}}{\frac{\text{Molecular weight PbO} - \text{Molecular weight PbSO}_4}{\text{Molecular weight PbSO}_4}} = \text{percentage of PbSO}_4\text{ present.}$$

Sulfur Dioxide.—Digest 2 g. of the sample with frequent stirring in 100 cc. of freshly boiled *cold* water and 5 cc. of concentrated HCl; let stand 10 to 15 minutes, add an excess of 0.01-normal iodine solution and titrate back with 0.01-normal sodium-thiosulphate solution, using starch indicator. Report as SO_2. Run blank on reagents and make corrections. Or, the SO_2 may be titrated directly with iodine.

Soluble Zinc Sulfate.—Determine as under "Zinc-Lead and Leaded Zincs."

ZINC-LEAD AND LEADED-ZINCS (OZLO WHITE).

Total Lead and Zinc.—Dissolve 1 g. of the sample by boiling with 250 cc. of water and 20 cc. of concentrated HNO_3, add 5 cc. of concentrated H_2SO_4, and evaporate to copious fumes of SO_3; cool, add 250 cc. of water, let stand *cold* 1 to 2 hours, filter on Gooch crucible, wash with 1-per-cent H_2SO_4, ignite, and weigh as $PbSO_4$. Report as $PbSO_4$. The $PbSO_4$ may be filtered on paper and then dissolved and titrated with ammonium-molybdate solution as described under basic carbonate of lead. Make filtrate from $PbSO_4$ alkaline with NH_4OH, then acid with HCl, add 3 cc. of concentrated HCl, heat to nearly boiling, and titrate the total zinc with potassium-ferrocyanide solution using uranium-acetate solution as an outside indicator and calculate to ZnO. (Iron, copper, or other interfering substances should first be removed as described by Low.)

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[a] This figure (99.70) is the average total percentage of $PbSO_4$, PbO, and ZnO, found in 270 total analyses of basic lead sulfate.

Sulfates other than Barium Sulfate.—Treat 0.5 g. of the sample with 5 cc. of water, 3 g. of NH_4Cl and 5 cc. of HCl saturated with bromine; digest (covered) on steam bath about 15 minutes, add 25 cc. of water, neutralize with dry Na_2CO_3, and add about 2 g. more, boil 10 to 15 minutes; let settle, dilute with hot water, filter and wash with hot water; redissolve in HCl, reprecipitate as above and wash thoroughly with hot water; acidify united filtrates with HCl, adding a slight excess; boil and add slight excess of 10-per-cent barium-chloride solution. Let stand on steam bath 1 hour, filter, wash with hot water, ignite, and weigh $BaSO_4$. Calculate to SO_3 (includes SO_3 formed from SO_2). Or, dissolve 0.5 g. of the sample in 25 cc. of water, 10 cc. of NH_4OH (sp. gr. 0.90) and HCl in slight excess; dilute to about 150 cc. with water and add a piece of aluminum foil which should about cover the bottom of the beaker—this held on bottom by means of a stirring rod. Heat gently till all lead is precipitated, decant through a filter, pressing the lead sponge with a flattened rod, and washing with hot water. Add to the filtrate a little pure bromine water, boil until bromine is expelled, add 15 cc. of 10-per-cent barium-chloride solution, let stand on steam bath one hour, filter, wash with hot water, ignite and weigh as $BaSO_4$ (any $SrSO_4$ present is not decomposed in this method).[1]

Soluble Zinc Sulfate.—Heat nearly to boiling 2 g. of the sample with 150 cc. of water and 50 cc. of 95-per-cent alcohol for 30 minutes, filter, and wash with a mixture of alcohol and water (1:3). Heat filtrate to boiling and expel most of the alcohol; then determine SO_3 by usual method of precipitation with $BaCl_2$. Calculate to $ZnSO_4$ and to SO_3.

NOTE.—If sample contains Ca or Mg, the Pb and Zn should be separated by precipitation with H_2S after dissolving in HCl, making alkaline with NH_4OH and acid with acetic acid. The PbS+ZnS is dissolved in dilute HNO_3 and the Pb and Zn determined as above.

Sulfur Dioxide.—Determine as under "Basic Sulfate of Lead" or "Zinc Oxide."

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[1] The solubility of $BaSO_4$ is increased by the presence of aluminium chloride. See J. W. Mellor, "A Treatise on Quantitative Inorganic Analysis," p. 615.

ZINC OXIDE.

Total Zinc.—Dissolve 0.25 to 0.3 g. in 10 cc. of concentrated HCl and 20 cc. of H_2O, make alkaline with NH_4OH, then acid with HCl, add 3 cc. more of concentrated HCl, dilute to about 250 cc. with H_2O, heat nearly to boiling and titrate with standard potassium-ferrocyanide solution as described by Low.[1] Report as ZnO (includes Cd). Iron, copper or other interfering substances should be first removed as described by Low.

Total Soluble Sulfur.[2]—Moisten a 10-g. sample with water, add a few drops of bromine and then concentrated HCl, boil to expel bromine, filter from any insoluble and wash with hot water. Make alkaline with NH_4OH, then just slightly acid with HCl, heat to boiling and add about 15 cc. of hot barium-chloride solution. Let stand several hours (over night), filter on a weighed Gooch crucible, wash well with hot water, dry, ignite for five minutes, cool and weigh as $BaSO_4$. Calculate to S.

Sulfur Dioxide.[2]—Mix 5 g. of sample with 50 cc. of warm (freshly boiled and then partly cooled) water to an emulsion and pour into a glass-stoppered flask containing 18 cc. of HCl and exactly 25 cc. of 0.1-normal iodine solution, stopper and shake until all the oxide is dissolved. Titrate the excess of iodine as rapidly as possible with 0.1-normal sodium-thiosulfate solution. Calculate to SO_2.

Soluble Zinc Sulfate.—Determine as under "Zinc-Lead and Leaded-Zincs."

LITHOPONE.

PONOLITH, JERSEY LILY WHITE, BECTON WHITE, CHARLTON WHITE, ORR'S WHITE.

Insoluble and Total Zinc.—Take 1 g. of the sample in a 200-cc. beaker, add 10 cc. of concentrated HCl, mix, and add in small portions about 1 g. of $KClO_3$, then heat on the steam bath until about half of the liquid is evaporated. Dilute with H_2O, add 5 cc. of dilute H_2SO_4 (1:10); boil, let settle, filter, wash, ignite, cool, and weigh the insoluble which should be only $BaSO_4$; make a qualitative examination for alumina and silica.

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[1] Low, "Technical Methods of Ore Analysis."

[2] Method of G. Rigg.

The insoluble should be examined under the microscope for the presence of natural crysallin barytes. Sample may also be examined direct. Make filtrate from insoluble alkaline with NH_4OH, acid with HCl, add 3 cc. of concentrated HCl, dilute to about 250 cc. with H_2O, heat nearly to boiling and titrate with $K_4Fe(CN)_6$ solution as under zinc white. Calculate to Zn.

Zinc Oxide.—Treat a 4-g. sample of the lithopone for 4 hours with 200 cc. of 1-per-cent acetic acid at room temperature, stirring occasionally. Filter by suction on a double filter paper and wash with cold water; add to the clear filtrate 13 cc. of concentrated NH_4OH, neutralize with HCl and then add 3 cc. of concentrated HCl in excess. Heat to boiling and titrate with $K_4Fe(CN)_6$, using uranium-acetate solution as an outside indicator. Calculate to ZnO. Calculate this result to Zn, subtract from total Zn, and calculate the difference to ZnS. (Any $ZnCO_3$ or $ZnSO_4$ is included in the ZnO.)

Zinc Sulfide.[1]—Place 0.5 g. of pigment in evolution flask with about 10 g. of "feathered" or mossy zinc, add 50 cc. of water; insert the stopper carrying a separatory funnel and an exit tube. Run in 50 cc. of concentrated HCl from the funnel, having previously connected the exit tube to two absorption flasks in series; first flask contains 100 cc. of alkaline lead-nitrate solution, second flask, 50 cc. of same as a safety device. After all of the acid has run into the evolution flask, heat slowly, finally boiling until the first appearance of steam in the first absorption flask; disconnect, let the lead sulfide settle, filter, wash with cold water, then with hot water till neutral to litmus paper and washings give no test for lead. The PbS precipitate is dissolved in hot, dilute HNO_3, evaporated to fumes with H_2SO_4 and finally weighed as $PbSO_4$. Calculate PbS or $PbSO_4$ to ZnS.

The alkaline lead solution is made as follows: Into 100 cc. of KOH solution (56 g. in 140 cc. of H_2O) pour a saturated solution of lead nitrate (250 g. in 500 cc. of H_2O) until the precipitate ceases to redissolve, stirring constantly while mixing. About 3 volumes of the lead solution will be required for one of the alkali.

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[1] Evolution Method of W. G. Scott, "White Paints and Painting Material," p. 257; see also Blair, "Chemical Analysis of Iron."

Instead of absorbing the evolved H_2S in alkaline lead-nitrate solution, a solution of 8 g. of cadmium chloride in 250 cc. of water and 150 cc. of NH_4OH (sp. gr. 0.90) may be used. The CdS precipitate may be filtered on a weighed Gooch, washed with water containing a little NH_4OH, dried at 100° C., and weighed. Calculate to ZnS. It is better to filter the CdS on a small filter and wash as above, then place filter and precipitate in a beaker and dissolve in HCl and $KClO_3$ (keeping at room temperature at first), filter out any paper pulp or insoluble matter; make filtrate alkaline with NH_4OH, then just acid with HCl, heat to boiling and precipitate with $BaCl_2$ in usual manner. Filter, wash, ignite, and weigh $BaSO_4$. Calculate to ZnS.

For very rapid work the contents of the absorption flask, after all H_2S has been absorbed, may be washed into a vessel with *cold* water and diluted to about one liter, acidified with concentrated HCl and titrated with standard iodine solution, using starch indicator. (The precipitate should be completely dissolved.) The iodine solution is prepared by dissolving about 12.7 g. of pure resublimed iodine and 18 g. of KI in a little water and then diluting to one liter.

CALCIUM PIGMENTS.

WHITING, PARIS WHITE, SPANISH WHITE, AND CHALK.

Make a qualitative examination first; should contain only small amounts of insoluble matter (siliceous), iron, aluminum, sulfur, water or magnesium, and should be approximately 95 per cent $CaCO_3$.

Total Soluble Lime.[1]—Weigh out 0.75 g. of the pigment into a small crucible, ignite cautiously to dull redness to destroy organic matter, cool, transfer to a 400-cc. beaker, add 20 cc. of H_2O, cover, then add 15 cc. of concentrated HCl and 3 or 4 drops of concentrated HNO_3, and boil till all the soluble matter is dissolved and all the CO_2 expelled. Wash off and remove the cover, dilute to about 150 cc. with freshly boiled H_2O, heat to boiling and add dilute NH_4OH (sp. gr. 0.96) carefully until a *slight* permanent precipitate forms. Heat to boiling and add 10 cc.

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[1] Meade, "Portland Cement."

of a 10-per-cent solution of oxalic acid; stir until the oxides of iron and aluminum are entirely dissolved and only a slight precipitate of calcium oxalate remains. Now add 200 cc. of boiling H_2O and sufficient saturated solution of ammonium oxalate (20 to 25 cc.) to precipitate the lime. Boil and stir for a few moments, remove from the heat, let settle and filter on an 11-cm. filter. Wash 10 times with 10-to-15-cc. portions of hot water. Place beaker in which precipitation was made under the funnel, pierce apex of filter with stirring rod and wash precipitate into beaker with hot water, pour warm dilute H_2SO_4 (1:4) through paper and wash a few times; add about 30 cc. of the dilute H_2SO_4 (1:4), dilute to about 250 cc., heat to 90° C. and titrate at once with standard $KMnO_4$ solution (solution should not be below 60° C. when end-point is reached). The $KMnO_4$ is best standardized against Bureau of Standards sodium oxalate.[1] Calculate to Cao and $CaCO_3$.

Mixed Calcium and Magnesium Carbonates.[2]—Weigh 1 g. of the finely powdered sample into a small porcelain dish, add 25 cc. of normal HCl, cover with a watch glass, and when effervescence has ceased, heat to boiling. Cool and titrate with normal NaOH solution, using methyl orange as indicator.

The calculation is as follows:

One gram CaO = 35.7 cc. of normal acid. $CaO \times 1.7844 = CaCO_3$. Subtract number of cubic centimeters of NaOH required from 25, result gives number of cubic centimeters of normal acid corresponding to the $CaCO_3 + MgCO_3$. Multiply the weight of CaO in 1 g. of sample (as found in preceding section on total soluble lime) by 35.7; product gives number of cubic centimeters of normal acid corresponding to the CaO present; subtract from total number of cubic centimeters of acid required by $CaCO_3 + MgCO_3$ and multiply result by 0.042, obtaining weight of $MgCO_3$ in 1 g. of sample. The $MgCO_3$ determined by this process should not differ more than 0.25 per cent from that obtained by more elaborate methods. It is to be noted that this method is a measure of the total alkalinity, and if Ca or Mg are present in other forms than carbonate, a complete analysis would be necessary to give percentages of $CaCO_3$ and $MgCO_3$.

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[1] *Circular No. 40*, Bureau of Standards.

[2] J. W. Mellor, "A Treatise on Quantitative Inorganic Analysis," p. 522.

Instead of the above, Newberry's[1] method for the simultaneous determination of calcium and magnesium carbonates may be used.

GYPSUM, TERRA ALBA, PLASTER OF PARIS.

Combined Water and Moisture.—Heat 1 g. of the sample in a covered porcelain crucible on an asbestos plate for 15 minutes, then heat bottom of crucible *dull red* for 10 minutes over a Bunsen burner, remove cover and heat for 30 to 40 minutes at a slightly lower temperature. Cool and weigh rapidly. Repeat to constant weight.

Combined water and moisture may also be determined by heating in an air bath at 200° C. to constant weight.

Insoluble Matter.—Boil 2 to 3 g. of the sample with 20 cc. of concentrated HCl, a few drops of HNO_3, and about 50 cc. of water; evaporate to dryness, boil residue repeatedly with 10-per-cent HCl, decanting through a filter; finally transfer to the filter, wash with hot water, ignite and weigh insoluble matter; test for $BaSO_4$. Make a qualitative examination of the filtrate from the insoluble matter to determine if Al, Fe, or Mg are present in abnormal amounts (should be mainly Ca and SO_3). Test a separate portion of the sample for CO_2; if desired determine as under "Basic Carbonate of Lead."

BARIUM PIGMENTS.

BARYTES OR BARITE, "BLANC FIXE."

Examine microscopically to determine uniformity of grinding, size and angularity of particles, crystallin or amorphous. Should be at least 95 per cent $BaSO_4$.

Loss on Ignition.—Ignite 1 g. of the sample for 30 minutes. Loss may be due to organic matter, moisture, combined water and CO_2 (and SO_3 from $CaSO_4$ if present). If loss is appreciable, test for CO_2.

Soluble and Insoluble Matter.—Boil 1 g. with HCl (1:3), filter, wash with hot water, ignite, and weigh insoluble matter.

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[1] Meade, "Portland Cement"; Mellor, "A Treatise on Quantitative Inorganic Analysis," p. 522; *Cement Engineering News*, Vol. 15, p. 35 (1903).

This may be treated with H_2SO_4 and HF in usual manner for SiO_2. In the absence of Al_2O_3 (from silicates) residue is considered as $BaSO_4$. Make qualitative tests of filtrate from the insoluble for Al, Fe, Ca, Mg, SO_3. Test a separate portion of sample qualitatively for CO_2.

SILICA PIGMENTS.

SILICA OR SILEX.

Silica or silex should be practically pure SiO_2. A qualitative examination will suffice in most cases with a determination of the loss on treating 1 g. of sample with H_2SO_4 and HF in usual manner.

CHINA CLAY AND ASBESTINE.

A qualitative analysis of China clay to determine if essentially hydrous aluminium silicate is generally all of the chemical tests necessary. Color, fineness, etc., are more important than analysis. Asbestine is tested qualitatively to prove that material is as represented. Color, fineness, etc., are important. Asbestine should be examined under the microscope to note whether it is fibrous or talcose and whether silica or China clay are admixed. Samples of known origin should be used here as a guide for comparison.

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE FORM

OF

SPECIFICATIONS FOR CERTAIN COMMERCIAL GRADES OF BROKEN STONE.

Serial Designation: D 35 – 16 T.

Criticisms of this Form of Specifications are solicited and should be directed to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

The broken stone shall consist of one product of the operation of a stone-crushing and screening plant without recombining or mixing, and shall conform to the following mechanical analysis using laboratory screens:

Passing screen having smallest holes selected	From .. to ..	per cent
Passing screen having next to largest holes selected	From .. to ..	"
Passing screen having largest holes selected	From .. to ..	"
Total passing screen having largest holes selected	100	"

Example.—The broken stone shall consist of one product of the operation of a stone-crushing and screening plant without recombining or mixing, and shall conform to the following mechanical analysis using laboratory screens:

Passing ¼-in. screen	3 to 10	per cent
Passing 1-in. screen and retained on ¼-in. screen	80 to 95	"
Passing 1¼-in. screen and retained on 1-in. screen	2 to 10	"
Total passing 1¼-in. screen	100	"

or the analysis may be expressed as follows:

Total passing ¼-in. screen	3 to 10	per cent
Total passing 1-in. "	90 to 98	"
Total passing 1¼-in. "	100	"

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TENTATIVE METHOD
FOR
DETERMINATION OF SOFTENING POINT OF BITUMINOUS MATERIALS OTHER THAN TAR PRODUCTS.

Serial Designation: D 36 – 16 T.

Criticisms of this Tentative Method are solicited and should be directed to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

Definition. 1. The Ring-and-Ball method shall be used.

Apparatus. 2. The apparatus shall consist of a brass ring 15.875 mm. ($\frac{5}{8}$ in.) in diameter, 6.35 mm. ($\frac{1}{4}$ in.) deep, 2.38125 mm. ($\frac{3}{32}$ in.) wall, suspended 25.40 mm. (1 in.) above bottom of beaker; a steel ball 9.525 mm. ($\frac{3}{8}$ in.) in diameter, weighing between 3.45 and 3.50 g.; a standardized thermometer; a glass beaker, approximately 600-cc. capacity. (See Fig. 1.)

Method. 3. Carefully melt the sample and fill the ring with the material to be tested. Remove any excess. Place the ball in the center of the ring and suspend in the beaker containing approximately 400 cc. of water at a temperature of 5° C. (41° F.). Arrange the thermometer bulb within $\frac{1}{2}$ in. of the sample and at the same level. Apply heat *uniformly* over bottom of the beaker in quantity sufficient to raise the temperature 5° C. (9° F.) per minute. Record the temperature at starting the test and every minute thereafter until the test is completed. The rate of heating is very important. The softening point is the temperature at which the specimen has dropped 1 in. Successive tests should average within 3° C. For temperatures above 9° C., glycerin shall be used instead of water.

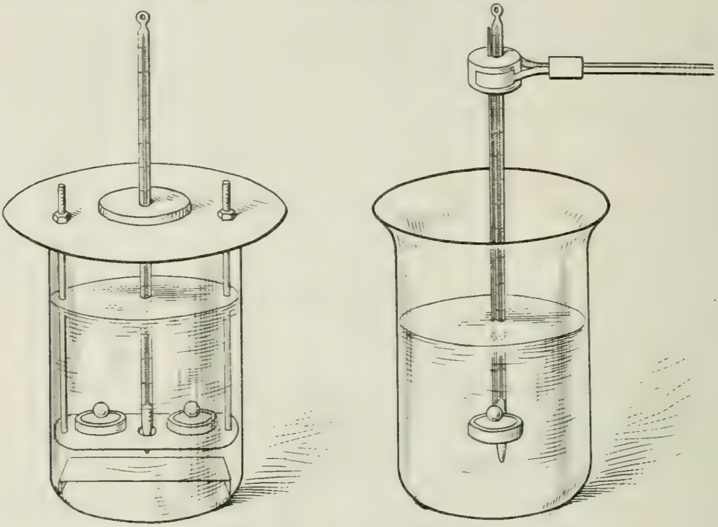

FIG. 1.—Apparatus for Determination of Softening Point.

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TENTATIVE METHODS
FOR
LABORATORY SAMPLING AND ANALYSIS OF COKE.

Serial Designation: D 37 – 16 T.

Criticisms of these Tentative Methods are solicited and should be directed to Mr. A. C. Fieldner, Secretary of Committee D-6 on Coke, Bureau of Mines, Pittsburgh, Pa.

DETERMINATION OF TOTAL MOISTURE
AND
PREPARATION OF LABORATORY SAMPLES.

APPARATUS.

Galvanized-Iron Pans 24 by 24 by 4 in. Deep.—For total moisture determination.

Balance or Solution Scale.—For weighing the galvanized-iron pans with samples. It should have a capacity of 10 kg. and be sensitive to 1 g.

Jaw Crusher.—For crushing coarse samples to pass a 4 mesh sieve.

Roll Crusher.—For reducing the 4-mesh product to 10-mesh.

Abbé Ball Mill or Hard-Steel Diamond Mortar.—For reducing the 10-mesh product to 60-mesh. The porcelain jars for the ball mill should be approximately 9 in. in diameter and 10 in. high. The flint pebbles should be smooth, hard and well rounded.

A Large Riffle Sampler, with $\frac{5}{8}$ or $\frac{3}{4}$-in. Divisions.—For reducing the 4-mesh sample to 5 lb. (Fig. 1).

A Small Riffle Sampler, with $\frac{1}{4}$ or $\frac{3}{8}$-in. Divisions.—For dividing down the 10 and 60-mesh material to a laboratory sample.

An 8-in. 60-mesh Sieve with Cover and Receiver.

Containers for Shipment to Laboratory.—Samples in which the moisture content is important should always be shipped in moisture-tight containers. A galvanized-iron or tin can with air-tight friction top or a screw top which is sealed with a rubber gasket and adhesive tape is best adapted to this purpose. Glass fruit jars sealed with rubber gaskets may be used, but require very careful packing to avoid breakage in transit. Samples in which the moisture content is of no importance need no special protection from loss of moisture.

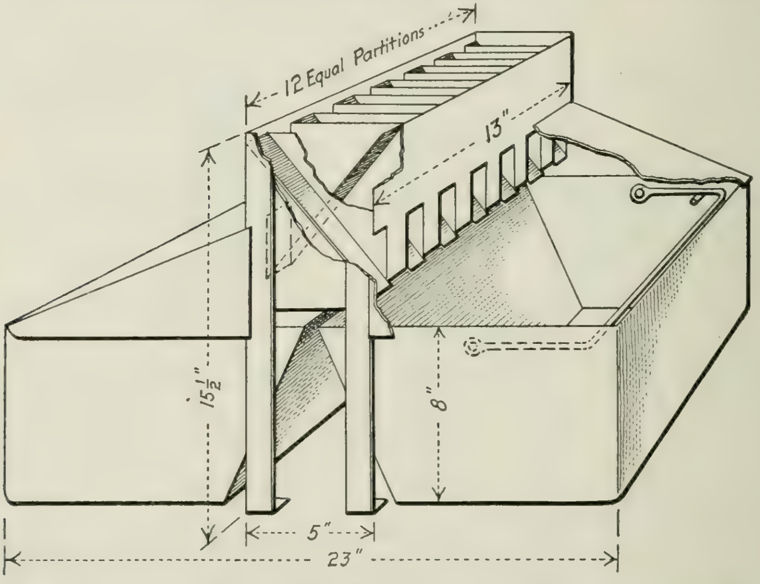

FIG. 1.—Riffle Sampler. (*Bulletin No. 9*, Geological Survey of Ohio, p. 213.)

Oven, Stove or Hot Plate.—For drying coke samples in the determination of total moisture. If an oven is used it should have openings provided for natural ventilation and should be capable of being regulated between 104 and 200° C. If the coke is dried on a stove or hot plate a thermometer should be placed in it, and care exercised that the temperature does not exceed 200° C. at any point in the pan of coke.

METHOD.

Total Moisture Determination.—Dry the entire sample received at the laboratory without any preliminary crushing to constant weight at a temperature of not less than 104 nor more than 200° C.[1]

Calculate the loss in weight to percentage of moisture, which shall constitute the total moisture in the coke as received at the laboratory.

The allowable difference in duplicate determinations by the same analyst is 0.5 per cent.

Reduction of Sample.—Crush the dried sample mechanically with a jaw or roll crusher, or by hand on a chilled iron or hard-steel plate by impact of a hard bar or sledge, avoiding all rubbing action, as otherwise the ash content will be materially increased by the addition of iron from the sampling apparatus, even though hardened iron or steel is used. Continue the crushing until all the sample passes through a 4-mesh screen, mix and quarter this to not less than 5 lb.; again crush the 5-lb. sample to a fineness of 10-mesh; mix and quarter to 400 g. Transfer this 400-g. portion to the porcelain jar of an Abbé ball mill and pulverize to 60-mesh. When pulverization is complete, pour the contents of the jar on a $\frac{1}{2}$-in. screen and separate the sample from the pebbles by shaking the screen. Reduce the quantity of sample by quartering or riffling to about 50 g. Pass the entire 50-g. portion through a 60-mesh sieve, pulverizing any coarse particles in a diamond mortar, and mix with remainder of sample, preserving the sample for analysis in a rubber-stoppered glass bottle.

In case a ball mill is not available for fine grinding, quarter the 5-lb. 10-mesh sample to 200 g. and pulverize to 60-mesh, by impact in a hard-steel diamond mortar. The use of rubbing surfaces such as a disk pulverizer or a bucking board is never permissible for grinding coke.

NOTES.

The accuracy of the method of preparing laboratory samples should be checked frequently by resampling the rejected portions and preparing a duplicate sample. The ash in the two samples should not differ more than 0.4 per cent.

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[1] Experiments made at the Bureau of Mines have shown that results checking within 0.5 per cent are obtained between these temperature limits.

DETERMINATION OF MOISTURE.

APPARATUS.

Moisture Oven.—An ordinary drying oven with openings for natural air circulation and capable of temperature regulation between limits of 104 and 110° C. may be used.

Capsules with Covers.—A convenient form, which allows the ash determination to be made on the same sample, is the Royal Meissen porcelain capsule No. 2, $\frac{7}{8}$ in. deep and $1\frac{3}{4}$ in. in diameter.

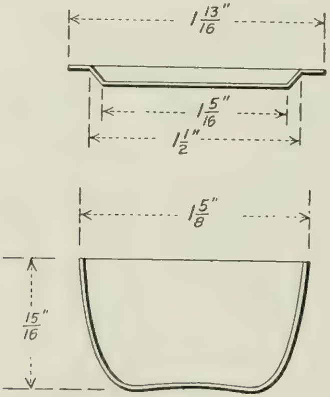

FIG. 2.—Porcelain Capsule with Flat Aluminum Cover.

This is to be used with a well-fitting flat aluminum cover, illustrated in Fig. 2.

Platinum crucibles or glass capsules with ground-glass caps may also be used. They should be as shallow as possible, consistent with convenient handling.

METHOD.

Heat the empty capsules under the conditions at which the coke is to be dried, stopper or cover, cool over concentrated sulfuric acid, sp. gr. 1.84, for 30 minutes, and weigh. Transfer to the capsule an amount slightly in excess of 1 g. and bring to exactly 1 g. in weight (±0.5 mg.) by quickly removing the excess weight of coke with a spatula.

Place the capsules, uncovered, in a pre-heated oven (at 104 to 110° C.). Close the oven at once and heat for 1 hour. Then open the oven, cover the capsules quickly and place them in a desiccator over concentrated sulfuric acid. When cool, weigh.

The percentage moisture in the 60-mesh sample shall be used to calculate the other results to a dry basis.

The permissible differences in duplicate determinations are as follows:

	PER CENT.
Same analyst	0.2
Different analysts	0.3

DETERMINATION OF ASH.

APPARATUS.

Gas or Electric Muffle Furnace or Meker Burner.—The muffle should have good air circulation and be capable of having its temperature regulated to not exceed 950° C.

Porcelain Capsules.—Royal Meissen Porcelain Capsules No. 2, $\frac{7}{8}$ in. deep and $1\frac{3}{4}$ in. in diameter, or similar shallow dishes or platinum crucibles.

METHOD.

Place the capsules containing the dried coke from the moisture determination in a muffle furnace or over a burner, and heat to redness at such a rate as to avoid mechanical loss. Finish the ignition to constant weight (±0.001 g.) at a temperature not exceeding 950° C. Cool in a desiccator and weigh.

The permissible differences in duplicate determinations are as follows:

	PER CENT.
Same analyst	0.2
Different analysts	0.3

NOTES.

Before replacing the capsules in the muffle for ignition to constant weight, the ash should be stirred with a platinum or nichrome wire. Stirring once or twice before the first weighing hastens complete ignition.

Test the ash for unburned carbon, by moistening it with alcohol; any carbon remaining will show as black particles.

DETERMINATION OF VOLATILE MATTER.

APPARATUS.

Platinum Crucible with Tightly Fitting Cover.—The crucible should be of 10-cc. capacity, with capsule cover having thin flexible sides fitting down into crucible. Or the double-crucible method may be used, in which the sample is placed in a 10 or 20-cc. platinum crucible, which is then covered with another crucible of such a size that it will fit closely to the sides of the outer crucible, and its bottom will rest $\frac{1}{3}$ to $\frac{1}{2}$ in. above the bottom of the outer crucible.

Vertical Electric Tube Furnace; or a Gas or Electrically Heated Muffle Furnace.—The furnace may be of the form shown in Fig. 3. It is to be regulated to maintain a temperature of 950° C. (±20° C.) in the crucible, as shown by a thermocouple kept in the furnace. A Meker burner may be used, if satisfactory to both parties to the contract.

METHOD.

Weigh 1 g. of the coke in a weighed 10-cc. platinum crucible, close with capsule cover and place on platinum or nichrome-wire supports in the furnace chamber, which must be at a temperature of 950° C. (±20° C.). After the crucible has been heated 2 or 3 minutes tap the cover lightly to more perfectly seal the crucible and thus guard against the admission of air. After heating exactly 7 minutes, remove the crucible from the furnace and, without disturbing the cover, allow it to cool in a desiccator. Weigh as soon as cold. The loss of weight minus moisture equals the volatile matter.

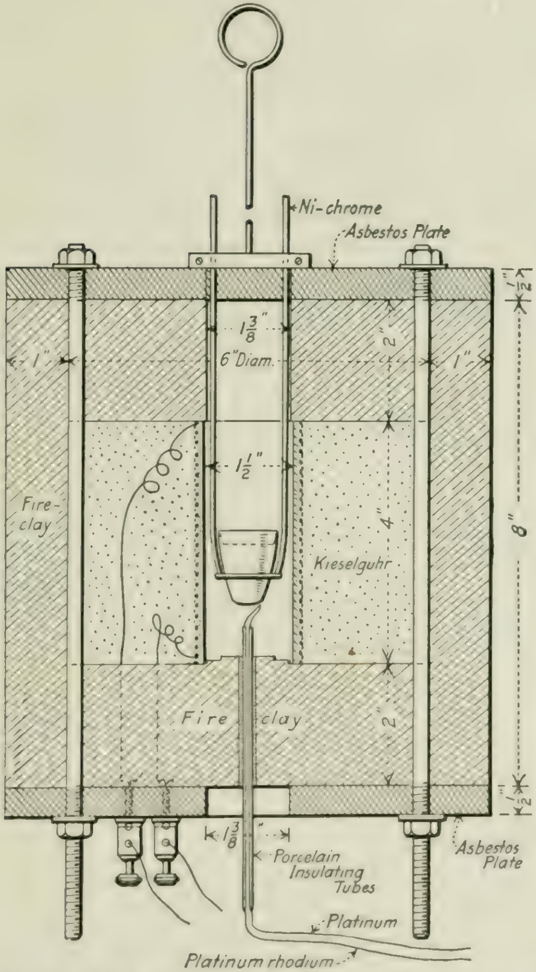

FIG. 3.—Electric Tube Furnace for Determining Volatile Matter. For 110-volt Alternating Current, 60 ft. of Nichrome Wire, No. 17 B. & S. Gage will give the required temperature. The temperature must be controlled by an external resistance. (*Technical Paper No. 76*, Bureau of Mines, p. 21.)

The permissible differences in duplicate determinations are as follows:

	PER CENT.
Same analyst	0.2
Different analysts	0.4

ALTERNATE METHOD, USING MEKER BURNER.

Weigh 1 g. of the coke in a weighed 10 or 20-cc. platinum crucible, close with capsule cover or another crucible as described above under "apparatus," and place in the flame of a No. 4 Meker burner, having approximately an outside diameter at the top of 25 mm. and giving a flame not less than 15 cm. high. The temperature should be 950° C. (± 20° C.), as determined by placing a thermocouple through the perforated cover, which for this purpose may be of nickel or asbestos. The junction of the couple should be placed in contact with the center of the bottom of the crucible; or the temperature may be indicated by the fusion of pure potassium chromate in the covered crucible (fusion of K_2CrO_4, 940° C.). The crucible is placed in the flame about 1 cm. above the top of the burner and the heating is continued 7 minutes. Where the gas pressure is variable it is well to use a U-tube attachment to the burner.

DETERMINATION OF FIXED CARBON.

Compute fixed carbon as follows:

$$100-(\text{moisture}+\text{ash}+\text{volatile matter}) = \text{percentage of fixed carbon.}$$

DETERMINATION OF SULFUR BY THE ESCHKA METHOD.

APPARATUS.

Gas or Electric Muffle Furnace, or Burners.—For igniting coke with the Eschka mixture and for igniting the barium sulfate.

Porcelain, Silica, or Platinum Crucibles or Capsules.—For igniting coke with the Eschka mixture.

No. 1 Royal Meissen porcelain capsule, 1 in. deep and 2 in. in diameter. This capsule, because of its shallow form, presents more surface for oxidation and is more convenient to handle than the ordinary form of crucible.

No. 1 Royal Berlin porcelain crucibles, shallow form, and platinum crucibles of similar size may be used. Somewhat more time is required to burn out the coke owing to the deeper form, than with the shallow capsules described above.

No. 0 or 00 porcelain crucibles, or platinum, alundum or silica crucibles of similar size are to be used for igniting the barium sulfate.

SOLUTIONS AND REAGENTS.

Barium Chloride.—Dissolve 100 g. of barium chloride in 1000 cc. of distilled water.

Saturated Bromine Water.—Add an excess of bromine to 1000 cc. of distilled water.

Eschka Mixture.—Thoroughly mix 2 parts (by weight) of light calcined magnesium oxide and 1 part of anhydrous sodium carbonate. Both materials should be free as possible from sulfur.

Methyl Orange.—Dissolve 0.02 g. in 100 cc. of hot distilled water and filter.

Hydrochloric Acid.—Mix 500 cc. of hydrochloric acid, sp. gr. 1.20, and 500 cc. of distilled water.

Normal Hydrochloric Acid.—Dilute 80 cc. of hydrochloric acid, sp. gr. 1.20, to 1 liter with distilled water.

Sodium Carbonate.—A saturated solution, approximately 60 g. of crystallized or 22 g. of anhydrous sodium carbonate in 100 cc. of distilled water.

Sodium-Hydroxide Solution.—Dissolve 100 g. in 1 liter of distilled water. This solution may be used in place of the sodium-carbonate solution.

METHOD.

Preparation of Sample and Mixture.—Thoroughly mix on glazed paper, 1 g. of 60-mesh coke and 3 g. of Eschka mixture.

Transfer to a No. 1 Royal Meissen porcelain capsule, 1 in. deep and 2 in. in diameter, or a No. 1 Royal Berlin crucible or platinum crucible of similar size, and cover with about 1 g. of Eschka mixture.

Ignition.—On account of the amount of sulfur contained in artificial gas, the crucible shall be heated over an alcohol, gasoline or natural gas flame, as in procedure (*a*) below, or in a gas or electrically heated muffle, as in procedure (*b*) below. The use of artificial gas for heating the coke and Eschka mixture is permissible only when crucibles are heated in a muffle.

(*a*) Heat the crucible, placed in a slanting position on a triangle, over a low flame at first, then gradually increase the temperature and stir occasionally until all the black particles disappear, which is an indication of the completeness of the procedure.

(*b*) Place the crucible in a warm muffle and gradually raise the temperature to 870–925° C. (cherry-red heat) in about ½ hour. Maintain this maximum temperature until on stirring all black particles have disappeared.

Subsequent Treatment.—Remove and empty the contents into a 200-cc. beaker and digest with 100 cc. of hot water for ½ to ¾ hour, with occasional stirring. Filter and wash the insoluble matter by decantation. After several washings in this manner, transfer the insoluble matter to the filter and wash 5 times, keeping the mixture well agitated. Treat the filtrate, amounting to about 250 cc., with 10 to 20 cc. of saturated bromine water, make slightly acid with hydrochloric acid and boil to expel the liberated bromine. Make just neutral to methyl orange with sodium-hydroxide or sodium-carbonate solution, then add 1 cc. of normal HCl. Boil again and add slowly from a pipette with constant stirring 10 cc. of a 10-percent solution of barium chloride ($BaCl_2.2H_2O$). Continue boiling for 15 minutes and allow to stand for at least 2 hours, or preferably overnight, at a temperature just below boiling. Filter through an ashless filter paper and wash with hot distilled water until a silver-nitrate solution shows no precipitate with a drop of the filtrate. Place the wet filter containing the precipitate of barium-sulfate in a weighed platinum, porcelain, silica or alundum crucible, allowing a free access of air by folding the paper over the precipitate loosely to prevent spattering. Smoke the paper off gradually and at no time allow it to burn with flame. After the paper is practically consumed raise the temperature to approximately 925° C. and heat to constant weight.

The residue of magnesia, etc., after leaching, should be dissolved in hydrochloric acid and tested with great care for sulfur. When an appreciable amount is found this should be determined quantitatively. The amount of sulfur retained is by no means a negligible quantity.[1]

Blanks and Corrections.—In all cases a correction must be applied either (1) by running a blank exactly as described above, using the same amounts of all reagents that were employed in the regular determination, or, more surely, (2) by determining a known amount of sulfate added to a solution of the reagents after these have been put through the prescribed series of operations. If this latter procedure is adopted and carried out, say, once a week or whenever a new supply of a reagent must be used, and for a series of solutions covering the range of sulfur content likely to be met with in coke, it is only necessary to add or to subtract from the weight of barium sulfate obtained from a coke whatever deficiency or excess may have been found in the appropriate "check" in order to obtain a result that is more certain to be correct than if a "blank" correction as determined by the former procedure is applied. This is due to the fact that the solubility error for barium sulfate is, for the amounts of sulfur in question and the conditions of precipitation prescribed, probably the largest one to be considered. Barium sulfate is soluble[2] in acids and even in pure water, and the solubility limit is reached almost immediately on contact with the solvent. Hence, in the event of using reagents of very superior quality or of exercising more than ordinary precautions, there may be no apparent "blank," because the solubility limit of the solution for barium sulfate has not been reached, or at any rate not exceeded.

(Weight of $BaSO_4 - \text{blank}) \times 13.73 = \text{percentage of sulfur}$.

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[1] *Journal*, Am. Chem. Soc., Vol. 21, p. 1128 (1899).

[2] *Journal*, Am. Chem. Soc., Vol. 32, p. 588 (1910); Vol. 33, p. 829 (1911).

The permissible differences in duplicate determinations are as follows:

	PER CENT.
Same analyst	0.03
Different analysts	0.05

DETERMINATION OF PHOSPHORUS IN ASH.

Method No. 1. To Cover all Cases.—To the ash from 5 g. of coke in a platinum capsule is added 10 cc. of nitric acid and 3 to 5 cc. of hydrofluoric acid. The liquid is evaporated and the residue fused with 3 g. of sodium carbonate. If unburned carbon is present 0.2 g. of sodium nitrate is mixed with carbonate. The melt is leached with water and the solution filtered. The residue is ignited, fused with sodium carbonate alone, the melt leached and the solution filtered. The combined filtrates, held in a flask, are just acidified with nitric acid and concentrated to a volume of 100 cc. To the solution, brought to a temperature of 85° C., is added 50 cc. of molybdate solution and the flask is shaken for 10 minutes. If the precipitate does not form promptly and subside rapidly, add enough ammonium nitrate to cause it to do so. The precipitate is washed six times, or until free from acid, with a 2-per-cent solution of potassium nitrate, then returned to the flask and titrated with standard sodium-hydroxide solution. The alkali solution may well be made equal to 0.00025 g. of phosphorus per cubic centimeter, or 0.005 per cent, for a 5-g. sample of coke, and is 0.995 of one-fifth normal[1] Or the phosphorus in the precipitate is determined by reduction and titration of the molybdenum with permanganate.

Note on Method No. 1.—The advantage of the use of hydrofluoric acid in the initial attack of the ash lies in the resulting removal of silica. Fusion with alkali carbonate is necessary for the elimination of titanium, which if present and not removed will contaminate the phospho-molybdate and is said to sometimes retard its precipitation.

Method No. 2.—When titanium is so low as to offer no objection, the ash is decomposed as under method No. 1, but evaporation is carried only to a volume of about 5 cc. The solution is diluted with water to 30 cc., boiled and filtered. If the washings are turbid they are passed again through the filter. The residue is ignited in a platinum crucible, fused with a little sodium carbonate, the melt dissolved in nitric acid and its solution, if clear, added to the main one. If not clear it is filtered. The subsequent procedure is as under method No. 1. The fusion of the residue may be dispensed with in routine work on a given coke if it is certain that it is free from phosphorus.

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[1] Ulmann and Buch, *Chemical Engineer*, Vol. 10, p. 130 (1909).

AMERICAN SOCIETY FOR TESTING MATERIALS

PHILADELPHIA, PA., U. S. A.

AFFILIATED WITH THE

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE METHODS

FOR

SAMPLING AND ANALYSIS OF CREOSOTE OIL.

Serial Designation: D 38 – 16 T.

Criticisms of these Tentative Methods are solicited and should be directed to Mr. Hermann von Schrenk, Chairman of Committee D-7 on Timber, Tower Grove and Flad Avenue, St. Louis, Mo.

Committee D-7 wishes to emphasize the great importance of the methods to be pursued in the actual taking of samples, so that the subsequent analysis will not be clouded by uncertainty as to whether the samples correctly represent the materials purchased. The committee feels that it is desirable when possible to base analyses on samples taken at the point of shipment, either accompanied by a sworn statement of the seller or taken under the inspection of the purchaser.

I. SAMPLING.

Continuous-Drip Sample.

1. Wherever the oil is being loaded or discharged by means of a pump the following method shall be used:

The pipe line through which the material is being pumped shall be tapped on the discharge side of the pump, preferably in a rising section of the pipe line. The sample shall be taken by means of a $\frac{1}{2}$-in. pipe extending half-way to the center of the main pipe, and the inlet of the $\frac{1}{2}$-in. pipe shall be turned to face the flow of the liquid. This pipe shall discharge into a barrel or drum of 50 or 100-gal. capacity, and the plug cock regulated so as to secure a continuous uniform stream during the entire pumping of the shipment. The barrel or preferably the iron drum should be provided with a small steam coil, sufficient to keep the contents thoroughly liquid. The temperature shall not exceed 120° F. The contents of the barrel or drum shall be very thoroughly agitated and small samples for testing taken immediately. The amount of the drip sample collected shall be not less than 1 gal. to 1000 gal. of material handled, excepting in the case of large boat shipments, where a maximum of 100 gal. will suffice.

Gravity Sample.

2. After considerable discussion and consideration of various methods, including those proposed by the American Railway Engineering Association in their 1915 report, the conclusion was reached that there is not enough evidence at hand to warrant the approval of any of these methods. The sub-committee recommends that several tank car shipments be actually handled under the supervision of a special joint committee of the various interested associations appointed for that purpose, in order that this important question may be satisfactorily settled.

Storage Tank Samples.

3. In sampling from storage tanks it is necessary to secure samples from different levels, and where possible this may be done by means of small outlet cocks at regular intervals from the top to the bottom of the storage tank. In such cases, about 1 gal. of tar or oil shall be drawn from each outlet cock and thoroughly mixed and a portion taken for testing. The stream from each cock shall always be allowed to flow for sufficient length of time to empty the outlet pipe and nipple before commencing to collect the sample.

When tanks have no outlet cocks, a vessel having a string attached to the cork may be lowered to measured depth, representing a number of the different levels in the tank and the cork removed when the vessel has reached the proper level. These samples shall be combined for an average as above.

II. ANALYSIS.

In view of the wide acceptance of the methods of analysis of the American Railway Engineering Association, Committee D-7 offers as its first work the following revision of these methods.

(*A*) *Distillation Test.*

Apparatus for Distillation Test.

4. (*a*) *Retort.*—This shall be a tubulated Jena glass retort of the usual form with a capacity of 250 to 290 cc. The capacity shall be measured by placing the retort with the bottom of the bulb and the end of the offtake in the same horizontal plane, and pouring water into the bulb through the tubulature until it overflows the offtake. The amount remaining in the bulb shall be considered its capacity. (Fig. 1.)

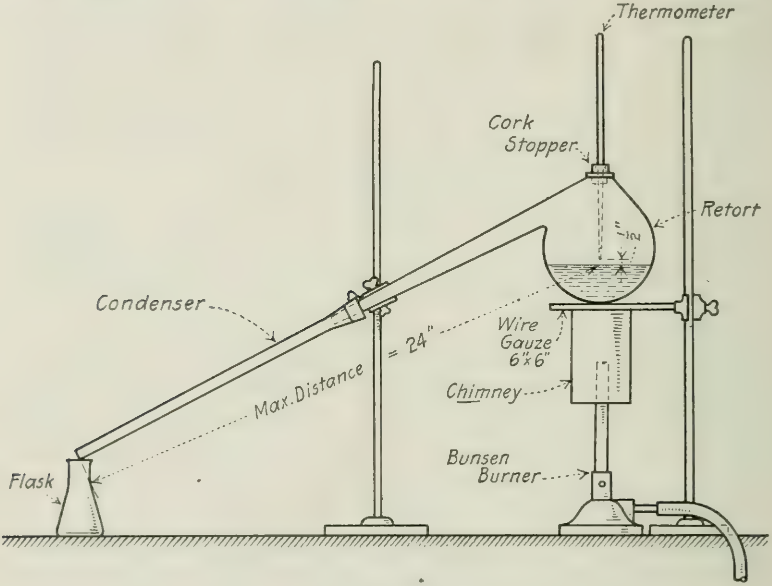

FIG. 1.—Distillation Apparatus.

(*b*) *Condenser Tube.*—Any suitable form of glass tubing may be used; a convenient one is shown in Fig. 1.

(*c*) *Shield.*—An asbestos shield as shown in Fig. 2 shall be used to protect the retort from air currents and to prevent radiation. This may be covered with galvanized iron, as such an arrangement is more convenient and more permanent.

(*d*) *Receivers.*—Erlenmeyer flasks of 50 to 100-cc. capacity are most convenient form.

(*e*) *Thermometer.*—The thermometer shall be of glass, well annealed, and shall undergo no serious change at the zero point when heated up to 400° C. The space above the mercury column shall be filled with gas, either carbon dioxide or nitrogen, and the thermometer shall have an expansion chamber at the top.

The scale shall read from 0 to 400° C., in graduations of 1° C., which shall be etched on the stem.

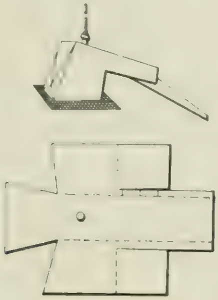

FIG. 2.—Asbestos Paper Shield.

The tip of the thermometer shall carry a ring for the purpose of attaching tags. The thermometer shall have the following dimensions:

Total length, 375 mm.; tolerance, 10 mm.
Bulb length, 14 mm.; tolerance, 1 mm.
Distance from zero mark to bottom of bulb, 30 mm.; tolerance, 4 mm.
Scale length from zero mark to 400° C., 295 mm.; tolerance, 5 mm.
Diameter of stem, 7 mm., tolerance, 1 mm.
Diameter of bulb, 6 mm., tolerance, 1 mm.

When standardized, the accuracy of such standardization should be as follows:

Up to 200° C.	to the nearest 0°.5 C.
200 to 300° C.	" " " 1°.0 C.
300 to 360° C.	" " " 1°.5 C.

Assembling for Distillation Test. 5. The retort shall be supported on a tripod or rings over two sheets of 20-mesh gage, 6 in. square. It shall be connected to the condenser tube by a tight cork joint. The thermometer shall be inserted through a cork in the tubulature with the bottom of the bulb $\frac{1}{2}$ in. from the surface of the oil in the retort. The exact location of the thermometer bulb shall be determined by placing a vertical rule graduated in divisions not exceeding $\frac{1}{16}$ in. back of the retort when the latter is in position for the test, and sighting the level of the liquid and the point for the bottom of the thermometer bulb. The distance from the bulb of the thermometer to the outlet end of the condenser tube shall be not more than 24 nor less than 20 in. The burner should be protected from draughts by a suitable shield or chimney. (Fig. 1.)

Distillation Test. 6. Exactly 100 g. of oil shall be weighed into the retort, the apparatus assembled and heat applied. The distillation shall be conducted at the rate of at least one drop and not more than two drops per second, and the distillate collected in weighed receivers. The condenser tube shall be warmed whenever necessary to prevent accumulation of solid distillates. Fractions shall be collected at the following points:

Up to 170° C., 170–200° C., 200–210° C., 210–235° C., 235–270° C., 270–315° C., 315–355° C.

The receivers shall be changed as the mercury passes the dividing temperature for each fraction. The last receiver shall be removed at 355° C., and drainage from the condenser, etc., shall not be considered as part of the fraction. For weighing the receivers and fractions, a balance accurate to at least 0.05 g. shall be used. During the progress of the distillation the thermometer shall remain in its original position. No correction shall be made for the emergent stem of the thermometer.

When any measurable amount of water is present in the distillate it shall be separated as nearly as possible and reported separately, all results being calculated on a basis of dry oil. When more than 2 per cent of water is present, water-free oil shall be obtained by separately distilling a larger quantity of oil, returning to the oil any oil carried over with the water, and using dried oil for the final distillation. A copper-tar still is a convenient means of obtaining water-free oil.

(B) *Specific Gravity Test.*

Apparatus for Specific Gravity Test.

7. (*a*) *Hydrometer.*—The hydrometer shall be of the form and dimensions shown in Fig. 3.

(*b*) *Cylinder.*—The cylinder shall be of the form and dimensions shown in Fig. 4.

Specific Gravity Test.

8. A standardized hydrometer (Fig. 3) shall be used. A set of two with ranges 1.00 to 1.08 and 1.07 to 1.15 will suffice.

The oil shall be brought to a temperature of 38° C. (100° F.), and the determination shall be made at that temperature unless the oil is not entirely liquid at 38° C. In case the oil requires to be brought to a higher temperature than 38° C. in order to render it completely fluid, it shall be tested at the lowest temperature at which it is completely fluid, and a correction made by adding 0.0008 to the observed specific gravity for each degree Centigrade above 38° C. at which the test is made. This correction factor does not apply with equal accuracy to all oils, but serious error due to its use will be avoided if the foregoing precaution is observed, with respect to avoiding unnecessarily high temperature. Before taking the specific gravity the oil

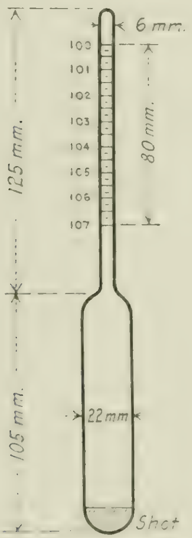

FIG. 3.—Hydrometer.

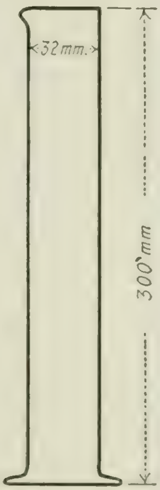

FIG. 4.—Cylinder.

in the cylinder should be stirred thoroughly with a glass rod, and this rod when withdrawn from the liquid should show no solid particles at the instant of withdrawal. Care should be taken that the hydrometer does not touch the sides or bottom of the cylinder when the reading is taken, and that the oil surface is free from froth and bubbles.

(*C*) *Determination of Insoluble Matter.*

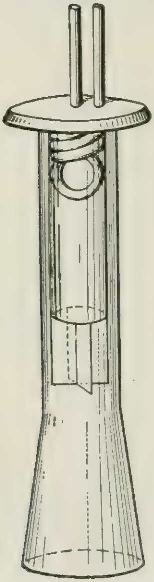

Fig. 5.—Extraction Flask, showing German Silver Wire Support for Filter Papers.

Apparatus. 9. (*a*) *Extractor.*—The extractor may be of the form shown in Fig. 5, or any similar form in which the oil is subjected to direct washing by the boiling vapors of the solvent.

(*b*) *Filtering Medium.*—The filtering medium may be either two thicknesses of S. & S. No. 575 hardened filter paper, 15 cm. in diameter, arranged in cup shape by folding symmetrically; or alundum thimbles, flat bottom, 30x80 RA 98. If filter papers are used, prior to using they shall be soaked in benzol to remove any grease, dried in a steam oven and kept in a desiccator until ready to be used. The filter-paper cup may be suspended in the extractor flask by a wire basket hung from two small hooks on the under surface of the metal cover of the flask. If the alundum thimble is used it may be supported by making two perforations in the top of the thimble, and suspending from the cover by German silver or platinum wires.

Tests. 10. Weigh 10 g. of dry oil in 100 cc. beaker. Add about 50 cc. of pure benzol and transfer at once to the filter cup. The filter cup or thimble is previously weighed, and the paper cup shall always be kept in a weighing bottle until ready for use. Wash out the beaker with benzol, passing all washings through the filter cup, and place latter at once in the extraction apparatus. Extractor shall contain a suitable quantity of pure benzol. Sufficient heat to boil the solvent shall be provided by means of an electric heater or a steam bath. Continue the extraction until the descending solvent is practically colorless, and remove the filter cup and dry in steam oven until all solvent is driven off; cool in desiccator and weigh. The balance used for this purpose should be accurate to within 0.5 mg.

(*D*) *Tar Acids.*

Tar Acids.

11. The determinations of tar acids by the method of the American Railway Engineering Association and other commonly used methods are inexact in their results, and Committee D-7 recommends further investigation, leading to the adoption of a new standard method.

(*E*) *Naphthalene.*

Naphthalene.

12. The American Railway Engineering Association method of determining naphthalene is not ordinarily practiced and is also inexact. Committee D-7 feels that for ordinary purposes visual examination of the fractions at normal temperature gives sufficient information as to the naphthalene content of the oil.

AMERICAN SOCIETY FOR TESTING MATERIALS

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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE GENERAL METHODS

FOR

TESTING COTTON FABRICS.[1]

Serial Designation: D 39 – 16 T.

Criticisms of these Tentative Methods are solicited and should be directed to Mr. W. D. Hartshorne, Chairman of Committee D-13 on Textile Materials, Methuen, Mass.

1. The following General Methods are intended to be applicable for testing cotton fabrics. Where a material requires special treatment, specific methods will be described as they are developed for that material and such special tests shall have precedence over the general method.

I. DEFINITION OF MOISTURE.

Dry Condition. 2. The dry condition of cotton material shall be understood to be absolute dryness obtained by material placed in a ventilated drying oven maintained at a temperature of 105 to 110° C. (221 to 230° F.) and dried to constant weight as determined by two consecutive weighings not less than ten minutes apart, and showing a further loss of not more than 0.1 per cent of the previous weighing.

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[1] In preparing these methods, Committee D-13 has had in mind especially automobile tire fabrics, hose and belting duck, and ordinary plain-weave cotton fabrics.

Standard Condition. 3. The standard condition[1] of cotton material shall be understood to be the condition in which it contains 8.5 per cent of its dry weight of moisture.

II. CHARACTERISTICS OF ROLL OR PIECE.

(*A*) *Length.*

Length. 4. The length of a roll or piece shall be determined by running the cloth over a measuring drum of known circumference, from which the yardage is registered by a dial or counter driven by a chain or other positive or non-slip mechanism. Just enough uniform tension[2] is to be used on the cloth to keep it running flat and true.

(*B*) *Width.*

Width. 5. (*a*) The width of a roll or piece shall be determined at five different places uniformly distributed along the full length of the roll or piece, and may be determined at the same time as the total length.

(*b*) The average of the five measurements shall be the width.

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[1] The amount of moisture which cotton contains when it is in moisture equilibrium with the space surrounding it, depends on both the relative humidity and the temperature. There is therefore a series of relative humidity-temperature values at which cotton will be in the "Standard Condition." The following table of values has been selected from Hartshorne's Unit Chart C. 2, and is published for the assistance of those who may be unable to control both the temperature and humidity to a single pair of values.

RELATIVE HUMIDITY-TEMPERATURE VALUES AT WHICH COTTON CONTAINS 8.5 PER CENT OF ITS DRY WEIGHT OF MOISTURE.

Temperature, deg. Fahr.	Relative Humidity, per cent.	Temperature, deg. Fahr.	Relative Humidity, per cent.
40	60.00	75	63.75
45	60.50	80	64.25
50	61.00	85	64.75
55	61.50	90	65.25
60	62.00	95	65.75
65	62.75	100	66.25
70	63.25		

[2] It has been suggested that a uniform tension of 2.5 times the weight of five running yards of the fabric will be sufficient to keep the fabric flat and preserve a proper relation for comparison of different fabrics. Invitation is extended to report to the committee the results of such tests upon different fabrics.

(*C*) *Weight.*

Net Weight. 6. All covering and binding material shall be removed and the net weight of the roll or piece quickly determined. A sample for the moisture test (described in Section 7) shall be taken immediately. The length and the width of the roll or piece (described in Sections 4 and 5) shall be determined quickly and accurately. As soon as the inner end is reached, a second moisture sample shall be taken.

Moisture. Content. 7. For the determination of the moisture content two test specimens of approximately equal area, the combined weight of which shall be at least 3.5 oz.[1] (100 g.), shall be taken as described in Section 6, one from each end of the roll or piece, placed in a dry, air-tight container, the weight of which has been previously determined, carefully weighed therein, then removed (a check weighing being made on the container), the net weight calculated and the sample dried to constant weight in the manner as described in Section 2 for dry condition. The difference between the original net weight of the sample and its dry weight is the loss of moisture. The percentage that this loss is of the original weight shall be considered the percentage moisture content of the roll.

Dry Weight. 8. The net weight of the roll or piece, less that weight multiplied by the percentage moisture content found as in Section 7, shall be considered the dry weight of the roll or piece.

The dry weight may also be computed from the moisture test by the following proportion:

$$\frac{\text{Net weight of sample}}{\text{Dry weight of sample}} = \frac{\text{Net weight of roll or piece}}{\text{Dry weight of roll or piece}}$$

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[1] For a fabric weighing 17½ oz. per sq. yd., at least 260 sq. in., 130 sq. in. from each end, would be required. It is not necessary that each of these test specimens be a continuous piece, but a strip 2.5 to 3 in. wide cut the entire width of a 60-in. fabric forms a convenient and representative sample because it contains portions of both the ends and the middle of the roll. If for other purposes of comparison it is desired to have the specimens of definite shape or aliquot parts of a square yard such as 9 or 16 or 24 sq. in., they may be conveniently cut with a sharp-edge circular die pressed upon a smooth but not too-hard surface such as block tin or sheet lead. Equal total areas could in this manner be readily taken from each end of the roll. Care should be exercised to handle the moisture specimens as little as possible, preferably with the hands covered by some type of dry, non-absorbent gloves and to place them in the air-tight weighing container immediately.

III. CHARACTERISTICS OF FABRIC.

(*A*) *Number of Threads per Inch.*

9. (*a*) The number of threads per inch or count of the fabric shall be determined by counting a space of at least 1 in. in at least five different places in the roll. **Number of Threads per Inch.**

(*b*) The average of the five determinations shall be the count.

(*B*) *Weight.*

10. The weight of the fabric per square yard shall be based upon the weight and length of a complete roll or piece and may be expressed either as (*a*) the dry weight, or (*b*) the standard weight, corresponding to "dry condition" and "standard condition," respectively. **Weight.**

For condition (*a*):

$$\text{Dry weight per square yard} = \frac{\text{Dry weight of roll}}{\text{Area of roll in square yards}}$$

For condition (*b*):

$$\left.\begin{array}{c}\text{Standard weight per}\\ \text{square yard}\end{array}\right\} = \frac{\text{Dry weight of roll} + (8.5\text{ per cent of dry weight})}{\text{Area of roll in square yards.}}$$

(*C*) *Thickness.*

11. (*a*) The thickness shall be measured by an automatic micrometer which presses upon at least 0.5 sq. in. of the fabric with a uniform constant pressure, and which is so mounted as to make measurements 6 in from the selvage. **Thickness.**

(*b*) At least ten measurements at different portions of the roll or piece shall be made, and the average shall be the thickness of the fabric.

(*D*) *Strength.*

12. For the determination of strength a 12-in. swatch, the width of the cloth, shall be taken from either end of the roll or piece, and the test specimens cut from it and tested as specified later. If by the first tests the fabric fails to meet the specifications a second swatch shall be taken as follows: **Sampling.**

If the roll or piece is a complete warp, the second swatch shall be cut from the center of the roll or piece. If the roll or piece is a part warp the second swatch shall be taken not less than 1½ yd. from the other end.

Speed. 13 The pulling clamp of the testing machine shall be power driven and shall travel at a uniform rate of 20 in. per minute.

Reporting Results. 14. The average results of tests should be reported separately for warp and filling.

Methods. 15. The strength may be determined either by (*a*) the "Strip Method" or (*b*) the "Grab Method."

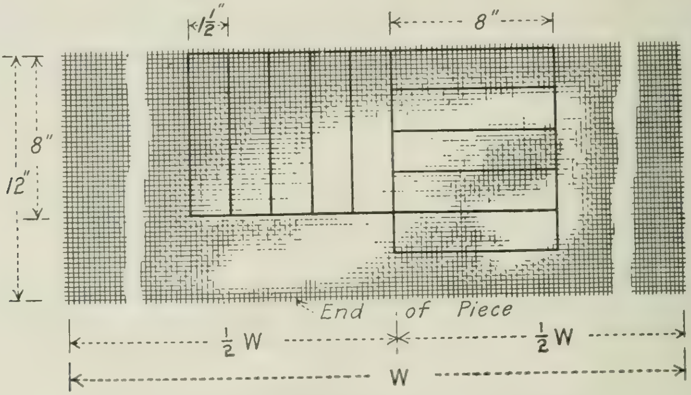

FIG. 1.—Location of Test Specimens, Strip Method.

Strip Method.

Preparation of Specimens: Strip Method. 16. (*a*) The test specimens shall be taken as follows: Starting at a line in the center, warpwise, lay off adjacent to this line five specimens on one side, parallel to the line (warp) and five specimens on the other side perpendicular to the line (filling). The test specimens shall be cut 8 in. long by 1½ in. wide, and shall be ravelled to the specified number of threads per inch by removing approximately an equal number of threads from each side of the required width. (See Fig. 1).

(*b*) Draw two parallel lines 3 in. apart on each test specimen as it lies flat without tension upon a smooth surface.[1]

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[1] These lines should be sharp and distinct. They may be quickly, conveniently and accurately made with a die, inked by means of an ordinary stamp pad. The die may consist of two metal strips set crosswise of the grain into a well-seasoned block of hard wood, the inner faces milled accurately parallel and 3 in. apart and the outer faces ground away so as to form a fine, but non-cutting edge. A die entirely of metal would of course be superior.

17. All jaws or clamps shall be at least 2 in. wide, and shall be of such design as to hold all threads without cutting or slipping. **Clamps.**

18. The length of test specimen between the jaws or clamps of the testing machine shall be 3 in. **Length of Specimen.**

19. The elongation or stretch at breaking shall be determined by measuring at the instant of breakage, by suitable means, the distance between the lines drawn 3 in. apart as specified in Section 16 (*b*). The increase in length of the 3-in. portion shall be the elongation and may be expressed either in units of length or as the percentage of 3 in. **Elongation.**

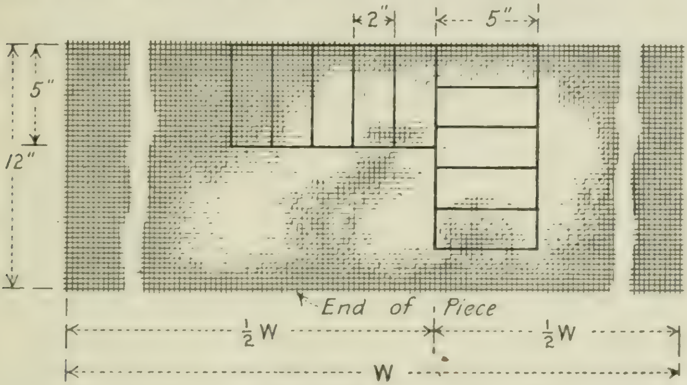

FIG. 2.—Location of Test Specimens, Grab Method.

Grab Method.

20. (*a*) The test specimens shall be taken as follows: Starting at a line in the center, warpwise, lay off adjacent to this line five specimens on one side, parallel to the line (warp) and five specimens on the other side perpendicular to the line (filling). The test specimens shall be cut 5 in. long by 2 in. wide. (See Fig. 2.) **Preparation of Specimens: Grab Method.**

(*b*) On each test specimen as it lies flat without tension on a smooth surface, draw pencil lines along the thread vertically and ½ in. from each edge so that 1 in. of fabric will be between them. Then draw pencil lines along the thread horizontally and 1 in. apart in the center of the specimen.

21. (*a*) On a vertical machine, use jaws at least 2 in. wide for the back, at both top and bottom, and 1-in. jaws for the front at both top and bottom. **Clamps.**

(*b*) On a horizontal machine, use jaws at least 2 in. wide for the under ones and 1-in. jaws for the upper ones.

Clamping of Specimen. 22. The test specimen shall be securely clamped in the two jaws of the machine, care being taken to see that the threads being tested are parallel to the direction of the pull and the cross threads are perpendicular to that direction.

Length of Specimen. 23. The length of test specimen between the jaws or clamps of the testing machine shall be 1 in.

Elongation. 24. The elongation or stretch at breaking shall be determined by measuring at the instant of breakage, by suitable means, the distance between the lines drawn 1 in. apart as specified in Section 20 (*b*). The increase in length of the 1-in. portion shall be the elongation and may be expressed either in units of length or as the percentage of 1 in.

TENTATIVE REVISIONS OF STANDARDS

Proposed revisions of or additions to existing Standards are published for one or two years under the general title of Tentative Revisions of Standards with a view of eliciting criticism, of which the committee concerned will take due cognizance before recommending final action towards the adoption of such Tentative Revisions by formal action of the Society.

Members of the Society and others are invited to direct written criticism of any of these Tentative Revisions of Standards to the officer of the appropriate committee whose name and address appear in connection with the title of each Tentative Revision.

AMERICAN SOCIETY FOR TESTING MATERIALS
PHILADELPHIA, PA., U. S. A.
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INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

TENTATIVE REVISIONS
OF
STANDARD TESTS FOR MAGNETIC PROPERTIES OF IRON AND STEEL.

Serial Designation: A 33 – 15.

Criticisms of these Tentative Revisions are solicited and should be directed to Mr. C. W. Burrows, Chairman of Committee A-6 on Magnetic Properties of Iron and Steel, Bureau of Standards, Washington. D. C.

The following Tentative Revisions of the Standard Tests for Magnetic Properties of Iron and Steel[1] were recommended by Committee A-6 at the annual meeting in 1916, and were accepted for publication without amendment[2]:

Strike out the last two paragraphs, which read:

> "The standard test for rods intended for permanent magnets shall consist in the measurement of the magnetizing force, the residual induction, and the coercive force corresponding to a maximum induction of 14,000 gausses.
>
> "Standard tests shall be made by the Burrows compensated double-yoke method (described in the *Standard Electrical Engineer's Handbook*, and also in *Technical Paper No. 117 of the Bureau of Standards*).",

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[1] 1916 Volume of A.S.T.M. Standards, p. 243.

[2] See Report of Committee A-6, p. 171.

and insert the following:

RESIDUAL INDUCTION AND COERCIVE FORCE.

The magnetic induction which exists in a piece of magnetic material when the magnetizing force has been reduced to zero is called the residual induction. The magnetizing force required to reduce this induction to zero is called the coercive force. The values of the residual induction and the coercive force depend upon the previous magnetic history. If the magnetic material has been normalized by proper demagnetization and repeated reversals of the magnetizing force, the corresponding quantities are called the normal residual induction (B_r) and the normal coercive force (H_c).

The standard data for material intended for permanent magnets shall consist of the normal induction (B), the normal residual induction (B_r), and the normal coercive force (H_c) corresponding to a magnetizing force of 200 gausses.

The standard magnetic data shall be determined by the Burrows compensated double-yoke method on test specimens prepared as indicated below.

The permeameter opening shall have a rectangular cross-section of 2 by 5 cm. (0.79 by 1.97 in.).

Sampling.—Each mill heat or lot shall be marked separately. The test sample shall consist of one test specimen from each of six different bars.

Size of Test Specimen.—The test specimen shall be 25 cm. (9.84 in.) or more long and shall be of such cross-section that it will pass through a rectangular tube whose cross-section is 2 by 5 cm. (0.79 by 1.97 in.).

Heat Treatment.—For steels of the following approximate chemical composition:

Carbon	0.50 – 0.70	per cent
Manganese	0.50 – 1.00	"
Phosphorus	0.05	"
Sulfur	0.03	"
Silicon	0.10	"

heat the specimen to 825° C. (1517° F.) and quench in water at 20° C.

For tungsten steel, heat the specimen to 845° C. (1550° F.) and quench in water at 20° C.

For other alloy steels, the heat treatment is to be determined by practical tests on test specimen.

The furnace shall be of such size that the specimen is heated to the required temperature in not over 30 minutes.

The furnace temperatures given above shall not vary by more than 10° C.

On quenching, the test specimen shall be removed quickly from the furnace. The test specimen shall not be allowed to cool over 10° C., after leaving the furnace and before immersion.

Immerse end-on or edgewise. The quantity of water shall be such that after quenching it is not over 50° C.

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TENTATIVE REVISIONS[1]
OF
STANDARD SPECIFICATIONS FOR SPELTER.

Serial Designation: B 6-14.

Criticisms of these Tentative Revisions are solicited and should be directed to Mr. Wm. Campbell, Chairman of Committee B-2 on Non-Ferrous Metals and Alloys, Columbia University, New York City.

The following Tentative Revisions of the Standard Specifications for Spelter[2] were recommended by Committee B-2 at the annual meeting in 1916, and were accepted for publication without amendment[3]:

1. In Section 1, change the grading of Virgin Spelter by the addition of the grade "Selected," to read as follows:

A.................High Grade.
B.................Intermediate.
C.................Brass Special.
D.................Selected.
E.................Prime Western.

---

[1] The revisions in Section 6 on Sampling and Section 7 on Analysis are based on the Report of the Sub-Committee on Methods of Analysis of Non-Ferrous Alloys of the Division of Industrial Chemists and Chemical Engineers of the American Chemical Society, approved by the Supervisory Committee on Standard Methods of Analysis of that Society.

[2] 1916 Volume of A.S.T.M. Standards, p. 423.

[3] See Report of Committee B-2, p. 180.

2. In Section 4, beginning at the heading "*C. Brass Special,*" change the remainder of the section, namely:

"*C. Brass Special.*—The spelter shall not contain over:

0.75 per cent lead.
0.04 " iron.
0.75 " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 1.20 per cent.

D. Prime Western.—The spelter shall not contain over:

1.50 per cent lead.
0.08 " iron.",

to read as follows:

"*C. Brass Special.*—The spelter shall not contain over:

0.60 per cent lead.
0.03 " iron.
0.50 " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 1.0 per cent.

D. Selected.—The spelter shall not contain over:

0.80 per cent lead.
0.04 " iron.
0.75 " cadmium.

It shall be free from aluminum.

The sum of the lead, iron, and cadmium shall not exceed 1.25 per cent.

E. Prime Western.—The spelter shall not contain over:

1.50 per cent lead.
0.06 " iron."

3. Strike out the present Section 6 on Sampling, namely:

"6. Not less than ten slabs shall be taken as a sample from each car; for smaller lots, in the same proportion to the total number, but in no case less than three slabs. In case of dispute half of the sample is to be taken by the maker and half by the purchaser; and the whole shall be mixed.

"The slabs selected as samples are to be sawed completely across and the sawdust used as a sample. In case no saw is available for this purpose, the slabs should be drilled completely through and the drillings cut up into short lengths. The saw or drill used must be thoroughly cleaned. No lubricant shall be used in either sawing or drilling, and the sawdust or drilling must be carefully treated with a magnet to remove any particles of iron derived from the tools.",

and substitute the following:

Sampling

"6. Select ten slabs at random from a carload and saw each slab completely across from the middle of one long side to the middle of the other and use the sawdust as the sample; or, drill three 9-mm. holes along one diagonal of each slab, boring completely through and taking care to make fine drillings; the holes should be drilled as nearly as possible at the middle and halfway between either end and the middle of such diagonals. Go over the drillings or sawings with a powerful magnet to take out any iron which may have come from the drill or saw, and mix the sample thoroughly. The drill or saw must be thoroughly cleaned before use, and no lubricant shall be used in either drilling or sawing."

4. Strike out the present Section 7 on Analysis, namely:

"7. *Lead.*—For the determination of lead in High Grade not less than 25 g., in Intermediate not less than 15, in Brass Special not less than 10, and in Prime Western not less than 5 g., shall be taken; that is, the sample used for analysis should not contain less than 0.01 g. lead.

Iron. The sample for iron should contain not less than 25 g. for the three higher grades and not less than 10 g. for Prime Western. The entire sample must be dissolved, the iron precipitated as ferric hydroxide, then redissolved, reduced, and the iron determined by titration.

Cadmium.—Dissolve 25 g. in 330 cc. of a solution of one part of hydrochloric acid (specific gravity 1.2) and five parts of water. Let it stand over night; filter and wash;

> reject filtrate and dissolve the residue, which should be about 5 per cent of the zinc, in nitric acid. Add 10 cc. of sulfuric acid; evaporate to fumes; dilute and filter out and wash the lead sulfate. Dilute the solution to 500 cc.; add 5 g. of ammonium chloride; pass a slow stream of hydrogen sulfide for one hour and let stand for about five hours; filter, wash with hot water; dissolve by boiling in 10 cc. of sulfuric acid and 50 cc. of water; filter and wash. Dilute to 400 cc.; precipitate with hydrogen sulfide as before. Weigh as cadmium sulfide or dissolve in hydrochloric acid and titrate with potassium ferrocyanide.",

and substitute the following:

Method of Analysis.

"7. *Lead.*—The Electrolytic and Lead-Acid methods described below are believed to be of equal merit, so far as accuracy is concerned, but where laboratories are equipped for electrolysis the electrolytic method is preferred as a time saver.

(*a*) *Electrolytic Method.*[1]—Place 8.643 g. of the sample in a 400-cc. beaker and add sufficient water to cover the sample. Then add gradually and cautiously 30 cc. of concentrated nitric acid (sp. gr. 1.42); when the action is complete boil the solution for a few minutes to expel nitrous fumes. Wash the watch glass and sides of the beaker and transfer the solution to a 200-cc. electrolytic beaker. Dilute to 125 cc. and electrolyze with a current of five amperes. The time required for the electrolysis is from ½ to ¾ hour, depending upon the amount of lead present in the sample. Test the solutions for complete precipitation of lead by washing the watch glasses and sides of the beaker, so that the depth of the solution is increased about 12 mm. Then continue the current for 15 minutes and if the newly exposed surface is still bright, the lead is completely deposited. Wash the anode three or four times with distilled water, once with alcohol and then dry in an oven, or on a hot plate, at 210° C. for ½ hour and weigh.

The weight of the PbO_2 in milligrams, divided by 100, will give the percentage of lead. The PbO_2 deposit can be readily removed by covering the anode with dilute nitric acid and inserting a rod of copper.

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[1] The empirical factor weight (8.643) is used instead of the theoretical one (8.66), as the dried dioxide is liable to contain some adherent and included water, expelled with difficulty. E. F. Smith's "Electro-Analysis," 4th edition, p. 102.

The electrodes are cylinders of platinum gauze with 400 meshes per sq. cm. The anodes are 30 mm. in diameter, by 30 mm. high, with a stem 105 mm. long of No. 16 Brown and Sharpe gage wire (1.29 mm.), making the total height 137 mm. The cathodes are 12 mm. in diameter by 30 mm. high, with a stem 105 mm. long of No. 16 Brown and Sharpe gage wire, making the total height 137 mm.

(*b*) *Lead-Acid Method.*[1]—Place in a 350-cc. beaker 25, 15, 10, 10 or 5 g. of the drillings or sawings, according to whether the spelter is of Grade A, B, C, D or E, respectively, and add, according to the size of the sample taken, 300, 180, 120, 120 or 60 cc. of lead acid. After all but about 1 g. of the zinc is dissolved, filter on a close filter and wash out the beaker a couple of times with lead acid from a wash bottle. Wash the undissolved matter from the filter into the original beaker with water and dissolve with a small amount of hot 1:1 nitric acid. Add 40 cc. of lead acid, and evaporate until strong fumes of sulfuric acid escape. When cool, add 35 cc. of water (which is the quantity of water evaporated from the lead acid), and heat to boiling. Add the first filtrate (containing the greater part of the zinc, and possibly a small amount of lead sulfate), stir well, and allow to stand for at least five hours, preferably over-night. Filter on a Gooch crucible, wash with lead acid, then with a mixture of equal parts of alcohol and water, and finally with alcohol alone. Set the Gooch crucible inside a porcelain crucible in order to avoid reduction of lead by flame gases and mechanical disintegration of the asbestos mat. Ignite for five minutes at the full heat of a Tirrell burner. Cool and weigh as $PbSO_4$.

Iron.—Place 25 g. of zinc in a tall 700-cc. beaker and dissolve cautiously in 125 cc. of nitric acid (sp. gr. 1.42). Boil, dilute to about 300 cc., add 10 g. of ammonium chloride, and then ammonia until the precipitated zinc hydroxide has redissolved. Boil, let settle and filter on an 11-cm. S. & S. "Black

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[1] "Lead Acid" is a solution of one volume of sulfuric acid in seven volumes of water, saturated with lead sulfate. It is prepared as follows: 300 cc. of sulfuric acid (sp. gr. 1.84) are poured into 1800 cc. of water; 1 g. of lead acetate is dissolved in 300 cc. of water and is added to the hot solution with stirring. The solution is allowed to settle for several days and is siphoned off through a thick asbestos filter for use. When "lead acid" is used it is unnecessary to consider the solubility of the lead sulfate, since the solution is always brought back to the same volume as the volume of "lead acid" originally added; consequently, when the lead sulfate is filtered no more lead remains in the filtrate than was originally added in the "lead acid."

Ribbon" or similar filter paper. Wash with dilute ammonia and with hot water. Dissolve the precipitated ferric hydroxide with hot 1:4 sulfuric acid, add 40 cc. of 1:1 sulfuric acid, pass through a Jones reductor,[1] wash first with 150 cc. of dilute sulfuric acid and then with 100 cc. of water and titrate with potassium permanganate. The potassium-permanganate solution contains approximately 0.2 g. of the crystals per liter. One cubic centimeter of permanganate solution will equal about 0.000334 g. of iron. Run a blank with the same amounts of acid and water and correct accordingly.

Standardize the potassium permanganate against sodium oxalate. Weigh duplicate samples of sodium oxalate, 0.0200 g. each, an amount which may require between 49 and 50 cc. of the permanganate solution. To convert sodium oxalate to iron, use the factor 0.833.

Cadmium.—Place 25 g. of drillings in a tall 500-cc. beaker; add 250 cc. of water and 55 cc. of concentrated hydrochloric acid and stir. When the action has almost ceased add more acid with stirring, using about 2 cc. at a time, and allowing to stand after each addition of acid, until finally all but about 2 g. of the zinc have been dissolved. About 60 cc. of acid in all are usually required; it is best to allow the first 55 cc. of acid to act over night. Filter, first transferring one of the undissolved pieces of zinc to the filter, and wash a couple of times with water. Discard the filtrate. Wash the undissolved matter on the filter paper into the 500-cc. beaker, cover, and dissolve in nitric acid. Transfer to a casserole, add 20 cc. of 1:1 sulfuric acid and evaporate until fumes appear, take up with about 100 cc. of water, boil, cool, and let settle for several hours (best over night). Filter off the lead sulfate on paper, wash with water, retain the filtrate and discard the lead sulfate. Dilute the filtrate to 400 cc., add about 10 g. of ammonium chloride, and pass hydrogen sulfide for one hour. It is occasionally necessary to start the precipitation of the cadmium sulfide by the addition of a drop or two of ammonia to the dilute solution. Allow to stand until the precipitate has settled, and then filter off the impure cadmium sulfide in a loose-bottom Gooch crucible; remove the cadmium sulfide by carefully punching out the bottom into a tall 200-cc. beaker. Wipe off any cadmium sulfide remaining on the sides of the crucible, using a little asbestos pulp, add 60 cc. of 1:5 sulfuric acid and boil for one-half hour. In case of spelters carrying large amounts of cadmium it may be necessary to add more acid. The dilute acid dissolves cadmium and zinc sulfides, but not lead sulfide. Filter and dilute to 300 cc., add about 5 g. of ammonium chloride and precipitate with hydrogen sulfide again in order to get rid of traces of zinc. In case a large amount of cadmium is present, a third precipitation may be necessary. After the final precipitation, let settle, filter and transfer to a weighed platinum dish, cover, and dissolve in 1:3 hydrochloric acid. Also dissolve the sulfide remaining on the filter paper in hot 1:3 hydrochloric acid, and add it to the solution in the platinum dish. Add a little sulfuric acid and evaporate the solution until copious fumes escape. Dilute with water, add a few cubic centimeters of concentrated nitric acid to oxidize any filter-paper shreds, and again evaporate the solution until fumes of sulfuric acid come off freely. Remove the excess of sulfuric acid by heating the dish cautiously, and finally heat to between 500 and 600° C. or to dull redness, and weigh the cadmium as sulfate.

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[1] If, before passing the solution through the reductor, a large amount of lead sulfate is present, it is well to filter it off so as to prevent it from clogging the reductor.

Alternate Method for Cadmium.—Proceed as above until the cadmium sulfide has been dissolved in hydrochloric acid. Oxidize with nitric acid and filter from sulfur. Transfer the solution to a 200-cc. electrolytic beaker, add a drop or two of phenolphthalein and then pure sodium or potassium-hydroxide solution until a permanent red color is obtained. Add a strong solution of pure potassium cyanide with constant stirring until the precipitate of cadmium hydroxide is completely dissolved. Avoid using an excess of the potassium cyanide. Dilute the solution to 150 cc. and electrolyze with a current of five amperes, using gauze electrodes of the same size as in the lead determination. The time required is 1 to 2 hours. The solution should always be tested for cadmium as follows: Raise the liquid in the beaker and then note after twenty minutes the newly exposed surface of the electrode. If it is still bright, the cadmium is completely deposited. Next wash the electrodes with distilled water and then with alcohol. Dry at 100° C., cool and weigh. The increase is metallic cadmium."

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TENTATIVE REVISIONS
OF
STANDARD SPECIFICATIONS AND TESTS FOR PORTLAND CEMENT.

Serial Designation: C 9–17.

Criticisms of these Tentative Specifications and Tests are solicited and should be directed to Mr. P. H. Bates, Secretary of Committee C-1 on Cement, Bureau of Standards, Pittsburgh, Pa.

The following Tentative Specifications and Tests for Compressive Strength of Portland Cement Mortar to be added to the Standard Specifications and Tests for Portland Cement[1] were recommended by Committee C-1 at the annual meeting in 1916, and were accepted for publication without amendment[2]:

SPECIFICATIONS AND TESTS FOR COMPRESSIVE STRENGTH OF PORTLAND CEMENT MORTAR.

SPECIFICATIONS.

Compressive Strength. 1. The average compressive strength in pounds per square inch of not less than three standard mortar test pieces (see Section 4) composed of one part cement and three parts standard sand, by weight, shall be equal to or higher than the following:

Age at Test, days.	Storage of Test Pieces.	Compressive Strength, lb. per sq. in.
7	1 day in moist air, 6 days in water	1200
28	1 day in moist air, 27 days in water	2000

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[1] 1916 Volume of A.S.T.M. Standards, p. 429.

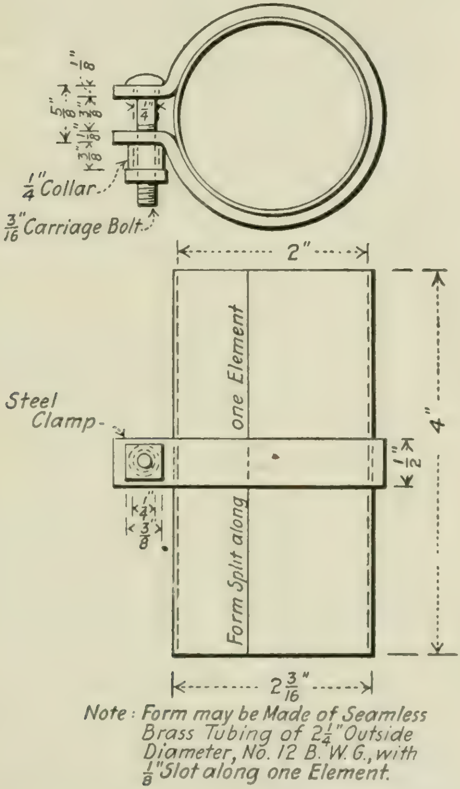
[2] See Report of Committee C-1, p. 200.

2. The average compressive strength of standard mortar at 28 days shall be higher than the strength at 7 days.

METHODS OF TESTS.

Mixing Standard Mortar.

3. The requirements governing the preparation of standard sand mortars for tension test pieces shall apply to compression test pieces.



Note: Form may be Made of Seamless Brass Tubing of 2¼" Outside Diameter, No. 12 B. W. G., with ⅛" Slot along one Element.

FIG. 1.—Details for 2 by 4-in. Cylinder Form.

Form of Test Piece.

4. A cylindrical test piece 2 in. in diameter and 4 in. in length is recommended for use in making compression tests of standards mortars. The molds shall be made of non-corroding metal. A satisfactory form of mold is shown in Fig. 1. The ends of the mold shall be parallel. The tubing used in the

molds shall be of sufficient thickness to prevent appreciable distortion. The molds shall be oiled before using. During the molding of the test piece, the mold shall rest on a clean, plane surface (preferably a piece of plate glass which is allowed to remain in place until the mold is removed).

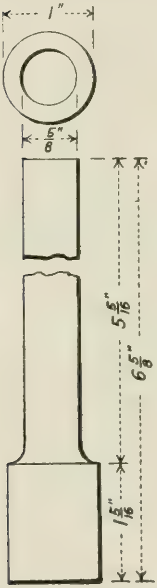


FIG. 2.—Details for Steel Tamper.

Molding. 5. The mortar[1] shall be placed in the mold in layers about 1 in. in thickness, each layer being tamped by means of the steel tamper shown in Fig. 2. The weight of tamper shall be approximately ¾ lb. In finishing the test piece, the mortar shall be heaped above the mold and smoothed off with a trowel. As soon as the test pieces from one sample are molded, the top of each test piece shall be covered with a piece of glass which is brought to a firm bearing on the fresh mortar. The cover glasses shall remain in place until the molds are removed.

Storage. 6. The compression test pieces shall be stored in the same manner as the tension test pieces.

Testing. 7. Tests of standard-mortar cylinders shall be made in any testing machine which is adapted to meet the specified requirements. The test pieces shall be tested as soon as removed from the water. The ends of the test cylinders shall be smooth, plane surfaces. The metal bearing plates of the testing machine shall be placed in direct contact with the ends of the test piece. During the test a spherical bearing block shall be used on top of the cylinder. In order to secure a uniform distribution of the load over the test cylinder the spherical bearing block must be accurately centered. The diameter of the spherical bearing block should be only a little greater than that of the test piece. The test piece shall be loaded continuously to failure. The moving head of the testing machine shall travel at the rate of not less than 0.05 or more than 0.10 in. per minute.

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[1] If sufficient mortar for six 2 by 4-in. cylinders is to be mixed in a single batch, approximately 3000 g. of material will be required. In this case the mixing shall be continued for 1½ minutes.

8. Testing machines should be frequently calibrated in order to determine their accuracy. **Calibration.**

9. Cylinders that are manifestly faulty, or which give strengths differing more than 15 per cent from the average value of all test pieces tested at the same period and made from the same sample, shall not be considered in determining the compressive strength. **Faulty Cylinders.**

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TENTATIVE REVISIONS

OF

STANDARD DEFINITIONS OF TERMS RELATING TO MATERIALS FOR ROADS AND PAVEMENTS.

Serial Designation: D 8-15.

Criticisms of these Tentative Definitions are solicited and should be directed to Mr. L. W. Page, Chairman of Committee D-4 on Road Materials, Office of Public Roads and Rural Engineering, Washington, D. C.

The following Tentative Definitions to be added to the Standard Definitions of Terms Relating to Materials for Roads and Pavements[1] were recommended by Committee D-4 at the annual meeting in 1916, and were accepted for publication without amendment[2]:

Clinker.—Generally a fused or partly fused by-product of the combustion of coal, but also including lava and Portland-cement clinker, and partly vitrified slag and brick.

Mesh.—The square opening of a sieve.

Slag.—Fused or partly fused compounds of silica in combination with lime or other bases, resulting in secondary products from the reduction of metallic ores.

Petroleum.—Liquid bitumen occurring as such in nature.

Topped Petroleum.—Petroleum deprived of its more volatile constituents.

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[1] 1916 Volume of A.S.T.M. Standards, p. 594.

[2] See Report of Committee D-4, p. 300.

Rock Asphalt.—Sandstone or limestone naturally impregnated with asphalt.

Bituminous Emulsion.—A liquid mixture in which minute globules of bitumen are held in suspension in water or a watery solution.

Viscosity.—The measure of the resistance to flow of a bituminous material, usually stated as the time of flow of a given amount of the material through a given orifice.

Penetration.—The consistency of a bituminous material expressed as the distance that a standard needle vertically penetrates a sample of the material under known conditions of loading, time and temperature. Where the conditions of test are not specifically mentioned, the load, time and temperature are understood to be 100 g., 5 seconds, and 25° C. (77° F.), respectively, and the units of penetration to indicate hundredths of a centimeter.

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